Attachment G

DAYFLOW DATA SUMMARY

FOR WATER YEARS 1955-56 THROUGH 1983-84

(First Publication of September 1984)

C-034539

REPRESENTATIVE DELTA ISLAND RETURN FLOW QUALITY FOR USE IN DSM2

MEMORANDUM REPORT
MAY 1995

Modeling Support Branch
Division of Planning
DEPARTMENT OF WATER RESOURCES

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SUMMARY

This memorandum report documents the development of representative Delta Island return flow quality for use in the Delta Modeling Section's new Delta Simulation Model (DSM2). Representative monthly values were developed for minerals, electrical conductivity, organic disinfection by-product precursors, BOD, nutrients, dissolved oxygen, temperature, and chlorophyll-a. These values will replace DSM's current specification of agricultural return quality (TDS and chloride) based on DWR's Bulletin 123. It is the Delta Modeling Section's intent to eventually simulate island return salinity and organic precursor quality with dynamic mathematical formulations; a contract with U.C. Davis beginning in June 1995 should help expedite the attainment of this goal.

Much of the work presented in this memorandum report is based on Municipal Water Quality Investigations data collected between 1982 and 1993. This data was collected and aggregated by the Division of Local Assistance. Other Department data sources were utilized as well.

INTRODUCTION

Salinity inputs from Delta islands have historically been simulated by the DWR Delta Modeling Section through specification of a "representative" monthly agricultural return quality. Representative return quality, given by total dissolved solids (TDS) and chloride, was assigned to DICU Delta subareas (*Estimation 1995*) based on data from DWR's Bulletin 123 (*Delta 1967*). These data were in turn used to compute salinity concentrations at DSM agricultural return nodes. For DSM nodes located on Bulletin 123 subregion boundaries, the computational procedure resulted in salinity concentrations that varied annually as well as monthly.

DWR's new Delta Simulation Model (DSM2) allows for simulation of many conservative and non-conservative constituents in addition to salinity. Therefore, there is now a need to model the loading of several water constituents in addition to TDS and chloride from agricultural return flows. DSM2 return nodes will continue to be assigned monthly-varying quality values until a dynamic agricultural return quality model is developed. However, these values will be assigned directly to nodes (rather than DICU subareas) and will not vary annually. The purpose of this memorandum report is to document the development of these new monthly return flow quality values. In this report, representative Delta island return flow quality is segregated into four categories for purposes of discussion: (1) minerals and electrical conductivity, (2) carbon, (3) nutrients, and (4) miscellaneous.

Because return quality data is not available for all of the approximately 250 drains in the Delta, spatial interpolation of available data was required. Spatial distribution of monthly values was developed in accordance with three primary sources. Two historic sources are DWR's Report 4 (*Quantity 1956*) and Bulletin 123 (*Delta 1967*). A third, more contemporary, source is spatially-aggregated data from DWR's Municipal Water Quality Investigations (MWQI) program. Aggregate statistics from this data are given in Appendix A (*MWQI 1995*). Report 4 segregated the Delta into 24 subregions, as shown in Fig. 1. Bulletin 123 segregated the Delta into 3 subregions: North, West and Southeast. See Fig. 2. The latter subregion is herein referred to as the South subregion. And as shown in Fig. 3, MWQI segregated the Delta into 3 dissolved organic carbon (DOC) subregions: high-DOC, mid-DOC and low-DOC (*Five-Year 1994*). Bulletin 123 subregions tend to aggregate Delta drains with similar source water influences, while MWQI subregions tend to aggregate Delta drains with similar soil type influences.

Monthly mineral and electrical conductivity values were, in general, developed from aggregated MWQI data and distributed spatially according to Bulletin 123 subregions. With two exceptions, carbon and miscellaneous values

were developed from aggregated MWQI data and distributed spatially according to DOC subregions. Nutrient values were developed from and spatially distributed according to Bulletin 123 subregions.

Interpolation and judgement were used liberally to translate from raw aggregated data to smoothed monthly values, given the sparceness of available data. With the exception of DOC and UV-254 data, this report does not address issues of uncertainty related to spatial and temporal interpolation. However, Appendix A provides some quantification of variability associated with the aggregated MWQI data via lower and upper quartile values.

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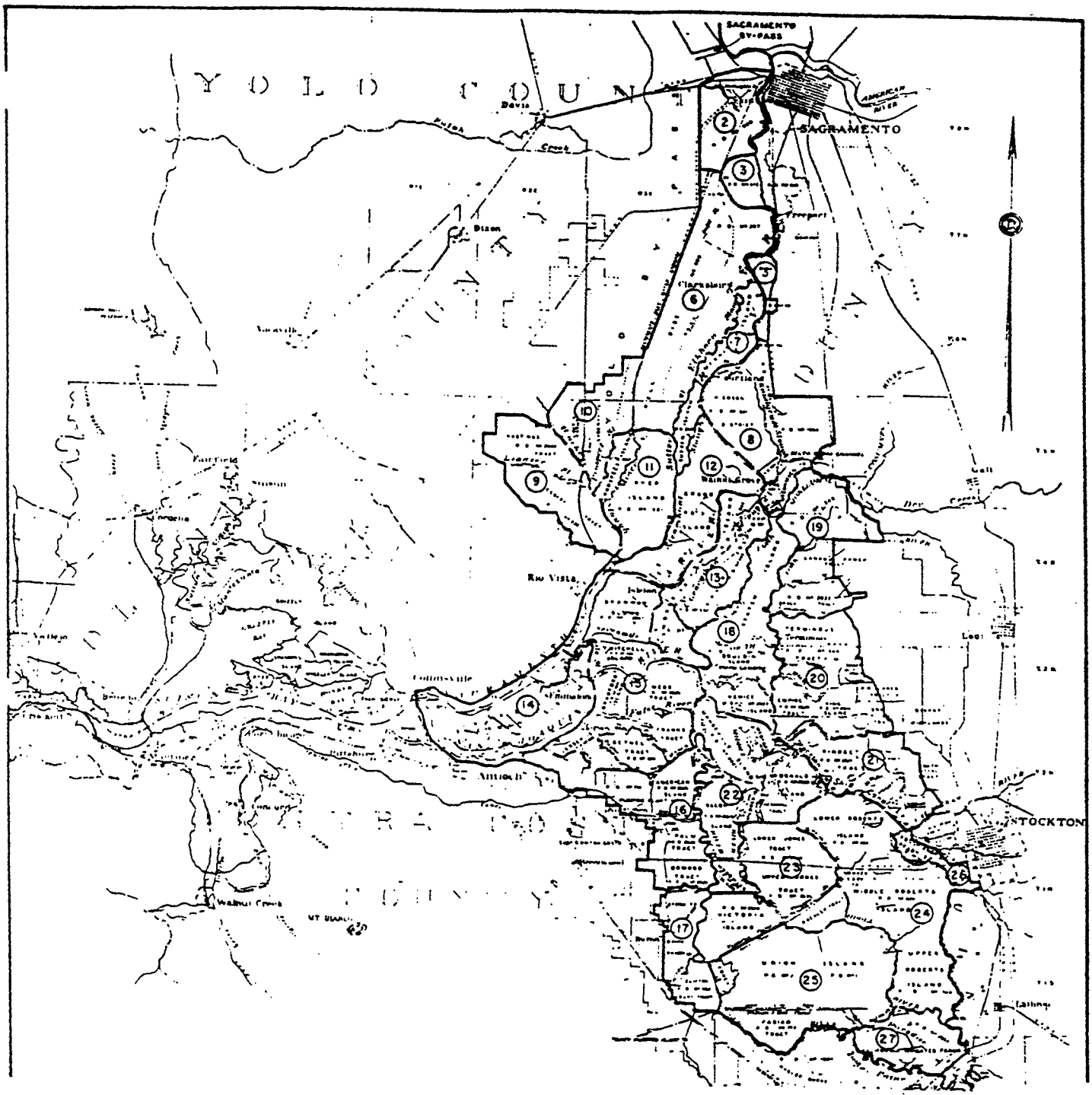

Figure 1. Report 4 Delta Subregions

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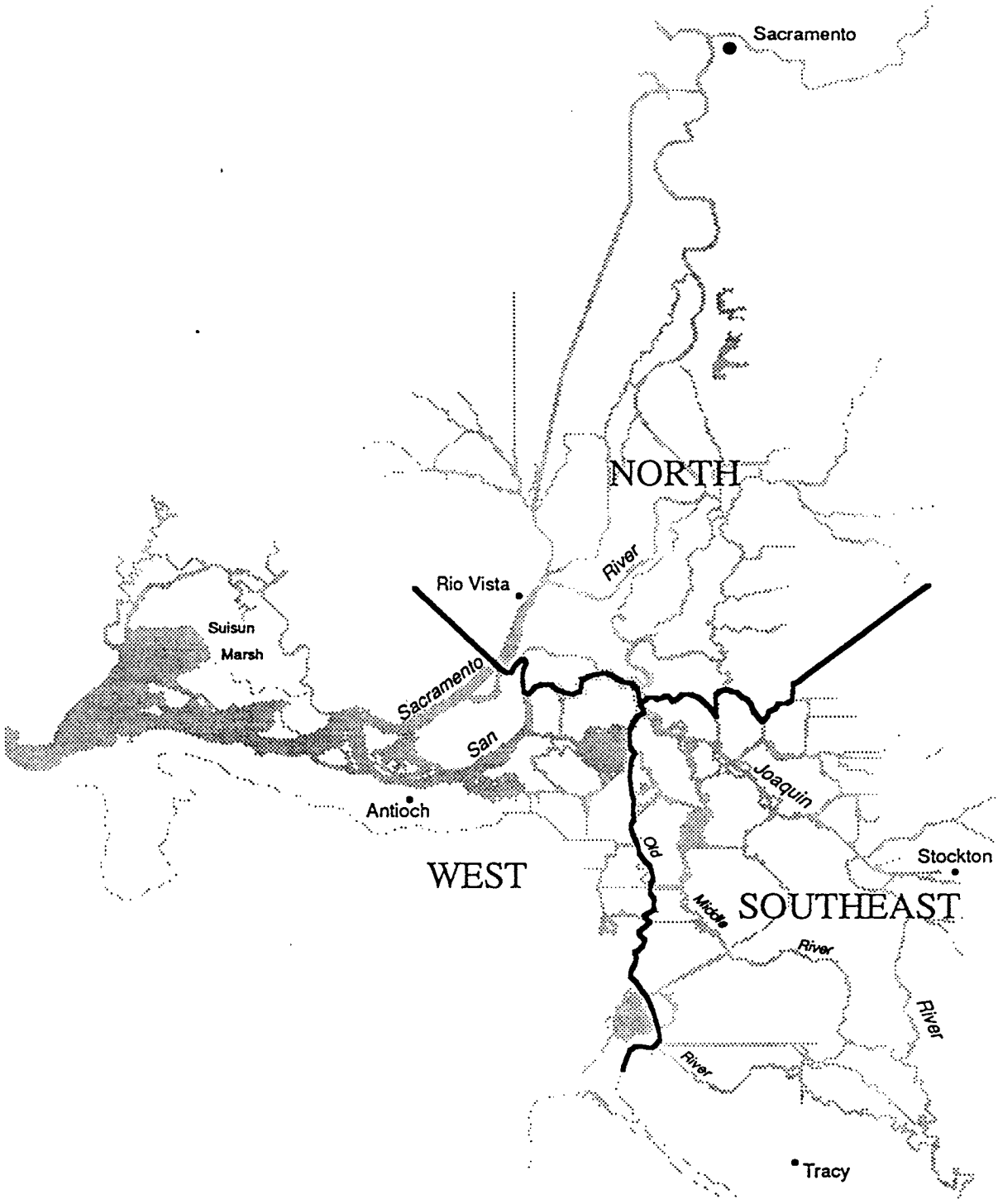

Figure 2. Bulletin 123 Delta Subregions

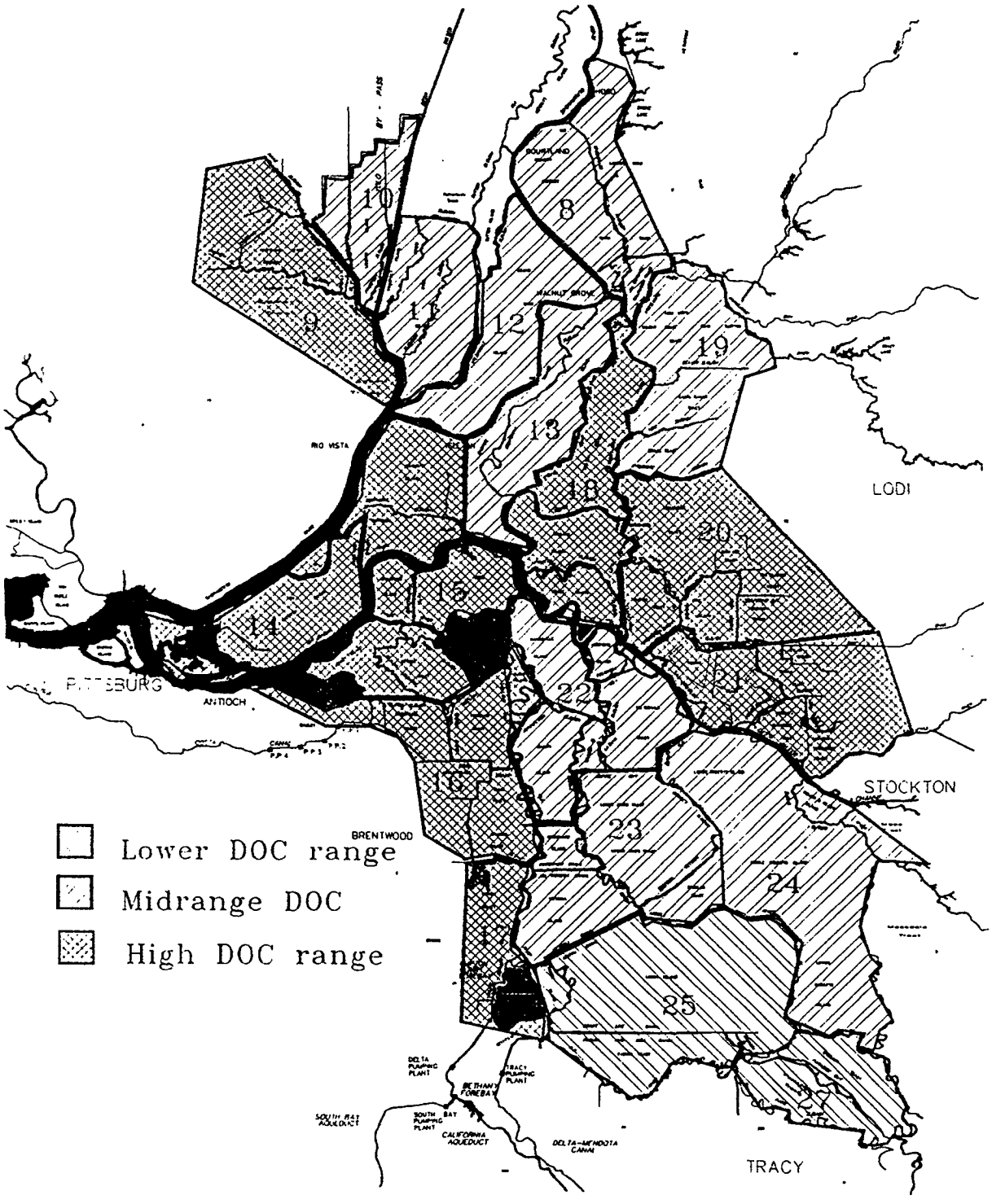

Figure 3. MWQI Delta Subregions

MINERALS & ELECTRICAL CONDUCTIVITY

Mineral water quality constituents considered in this report include TDS, alkalinity, bromide, calcium, chloride, magnesium, sodium, and sulfate. Electrical conductivity (EC), a surrogate measure of mineral content, is also included in this category. Monthly mineral values are delineated by Bulletin 123 subregion and are based in general on aggregated MWQI data given in Appendix A.

Chloride and TDS are often used in simulation studies to track movement of salinity, with chloride being the most conservative, and therefore reliable, measure. Other mineral constituents are useful in characterizing or "fingerprinting" diversion water sources and their influences on return water quality. Alkalinity data are included in this report to check the consistency of smoothed monthly values with respect to total mineral concentration as well as ionic charge balance. There are no immediate plans to simulate carbonate chemistry in the Delta. Further discussion on internal checks is provided in a subsequent section.

Data Smoothing

Monthly values for minerals and EC were developed in the following manner. First, smoothed monthly TDS values were developed from MWQI and Report 4 data. Second, simple linear correlations were determined between average mineral and TDS concentrations reported in the aggregated MWQI data. Regression coefficients are given in Table 1. Third, the correlations were used to compute smoothed monthly mineral concentrations. Smoothed monthly mineral and EC values are summarized in Table 2 and are graphically compared with unsmoothed data in Appendix B.

Total Dissolved Solids (TDS)

Monthly TDS estimates from Report 4, Bulletin 123, and MWQI are compared for each Bulletin 123 subregion in Table 3. Values referred to as "Report 4" estimates were not actually computed in the original reference. The "Report 4" estimates were computed for this study as flow-weighted averages by Bulletin 123 subregion using Tables 10 and 16 of the original reference. Values referred to as "Bulletin 123" estimates were taken directly from Table 20 of the original reference. Table 3 shows similarities between Report 4 and MWQI estimates, both in terms of spatial trends and temporal trends. Both estimates show highest TDS concentrations in the West subregion and lowest TDS concentrations in the North subregion; both estimates also show maximum concentrations in the winter and minimum concentrations in the summer. In contrast, the Bulletin 123 estimates show the South region to generally have the highest TDS concentrations; these concentrations are at a maximum in the fall. Bulletin 123 estimates were therefore judged to be less representative of agricultural return quality that the other estimates.

Table 1. Linear Correlations Between Minerals and TDS: MWQI Data
$Y = \Phi_1 + \Phi_2$ TDS

Region	Y	Φ_1	Φ_2	R^2
North	Alk	57.	0.214	0.54
North	Br	-----	-----	-----
North	Ca	0.8	0.0931	0.996
North	Cl	7.1	0.120	0.65
North	EC	35.	1.34	0.98
North	Mg	-2.6	0.0780	0.89
North	Na	6.6	0.0911	0.91
North	SO_4	-47.	0.283	0.90
West	Alk	-----	-----	-----
West	Br	-----	-----	-----
West	Ca	-17.	0.108	0.98
West	Cl	81.	0.161	0.89
West	EC	218.	1.30	0.99
West	Mg	-5.3	0.0597	0.995
West	Na	49.	0.102	0.94
West	SO_4	-193.	0.465	0.98
South	Alk	-----	-----	-----
South	Br	-----	-----	-----
South	Ca	-5.6	0.109	0.99
South	Cl	-36.	0.340	0.91
South	EC	82.	1.50	0.93
South	Mg	-1.7	0.0553	0.98
South	Na	23.	0.118	0.87
South	SO_4	17.	0.126	0.87

Table 2. Smoothed Monthly Mineral Concentrations (mg/L) and ECs (µS/cm)

AREA	MONTH	Alk	Br	Ca	Cl	Mg	Na	SO_4	TDS	EC
North	Jan	181	0.31	55	76	42	59	117	578	809
North	Feb	182	0.34	55	77	43	60	119	586	821
North	Mar	177	0.37	53	75	41	58	112	562	788
North	Apr	155	0.39	43	62	33	48	83	457	648
North	May	121	0.33	29	43	21	34	38	300	436
North	Jun	112	0.26	25	38	17	30	26	256	378
North	Jul	106	0.17	22	34	15	27	18	228	340
North	Aug	112	0.21	25	38	17	30	26	256	377
North	Sep	121	0.30	29	43	21	34	38	300	437
North	Oct	133	0.40	34	50	25	39	54	357	513
North	Nov	147	0.37	40	58	30	45	72	420	598
North	Dec	164	0.34	47	67	36	52	95	500	705
West	Jan	140	0.66	98	252	58	157	301	1062	1598
West	Feb	140	0.59	122	288	72	180	406	1288	1892
West	Mar	140	0.57	105	263	62	164	332	1128	1685
West	Apr	140	0.55	82	228	49	142	232	915	1407
West	May	140	0.53	58	193	36	120	130	695	1121
West	Jun	140	0.52	46	175	29	108	77	582	974
West	Jul	140	0.51	43	171	28	106	66	556	941
West	Aug	140	0.50	44	173	29	107	71	569	957
West	Sep	140	0.60	49	179	31	111	91	610	1011
West	Oct	140	0.70	55	189	35	117	119	670	1089
West	Nov	140	0.69	64	202	39	126	156	750	1193
West	Dec	140	0.68	80	226	48	141	226	900	1388
South	Jan	140	0.66	87	252	45	123	124	847	1352
South	Feb	140	0.59	82	236	43	117	118	799	1281
South	Mar	140	0.57	78	226	41	114	114	771	1239
South	Apr	140	0.55	67	190	35	102	101	666	1081
South	May	140	0.53	50	139	27	84	82	514	852
South	Jun	140	0.52	45	122	24	78	76	464	779
South	Jul	140	0.51	42	113	23	75	72	438	739
South	Aug	140	0.50	41	109	22	73	71	426	720
South	Sep	140	0.60	46	125	24	79	77	473	791
South	Oct	140	0.70	52	144	28	86	84	530	877
South	Nov	140	0.69	60	168	31	94	93	600	982
South	Dec	140	0.68	71	204	37	106	106	707	1142

Table 3. TDS Estimates in mg/L: Report 4, Bulletin 123, MWQI Data

AREA	MONTH	REPORT 4	BULL 123	MWQI
North	Jan	602	859	554
North	Feb	600	907	572
North	Mar	531	788	593
North	Apr	447	618	468
North	May	266	419	333
North	Jun	267	180	299
North	Jul	208	197	248
North	Aug	236	244	275
North	Sep	273	332	234
North	Oct	307	609	406
North	Nov	385	598	345
North	Dec	556	829	397
West	Jan	1104	891	1020
West	Feb	1221	1050	1355
West	Mar	1128	1050	-----
West	Apr	1000	962	830
West	May	695	649	-----
West	Jun	563	452	600
West	Jul	571	556	541
West	Aug	611	672	527
West	Sep	678	539	-----
West	Oct	715	575	625
West	Nov	849	485	-----
West	Dec	1110	796	-----
South	Jan	895	860	798
South	Feb	782	956	817
South	Mar	658	1005	884
South	Apr	667	1020	665
South	May	465	860	562
South	Jun	391	680	538
South	Jul	361	673	515
South	Aug	378	857	473
South	Sep	473	1004	-----
South	Oct	493	1208	702
South	Nov	506	1412	-----
South	Dec	707	834	537

Based on Report 4 and MWQI estimates, smoothed monthly TDS values were developed by inspection to approximate continuous changes in concentration over time. As shown in Fig 4, smoothed TDS concentrations range between 228-586 mg/L in the North subregion, 556-1288 mg/L in the West subregion, and 426-847 mg/L in the South subregion. Smoothed and unsmoothed values are compared in Figs. B-1, B-2 and B-3.

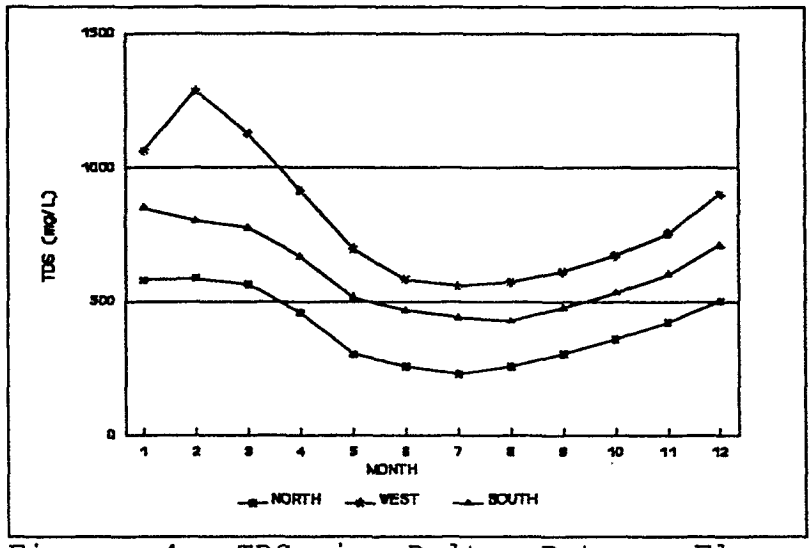

Figure 4. TDS in Delta Return Flows: Smoothed Monthly Values by Subregion

Alkalinity

There are no immediate plans to model carbonate chemistry in the Delta; alkalinity values are reported to assist in the internal checks discussed in a subsequent section. Alkalinity is reported in units of mg/L as calcium carbonate.

In the North subregion, alkalinity appears to follow a seasonal trend and correlates reasonably well with TDS. Therefore, smoothed monthly values were estimated from smoothed TDS values (see Fig. B-4). Smoothed values vary between a February maximum of 182 mg/L and a July minimum of 106 mg/L. In the other subregions, a seasonal trend was not apparent and correlations with TDS did not exist. Therefore, a representative value of 140 mg/L was assigned to these subregions.

To perform the internal checks discussed in a subsequent section, concentration units were modified. Alkalinity was expressed as meq/L of bicarbonate ion in the anion sum calculation and was expressed as mg/L of carbonate in the total mineral calculation (*Hem 1985*).

Bromide

The aggregated MWQI data set does not show a strong correlation between bromide concentration and TDS or other mineral concentrations. Therefore, monthly values were not computed from smoothed TDS values. As shown in Figs. B-5 and B-6, scarcity of bromide data made substantial interpolation and smoothing (by inspection) necessary. Bromide concentrations in the West and South Delta regions were similar enough to justify assigning identical values to each subregion. For reasons not readily explainable, the trend for these regions appears to be somewhat

different that for the other minerals -- maximum values occur in the fall rather than winter. Bromide concentrations range from 0.50-0.70 mg/L. The North subregion exhibits lower concentrations, ranging from 0.17-0.40 mg/L. The North subregion shows peak concentrations in the spring and fall. It is recommended that these estimates be updated as more data becomes available.

Calcium

Monthly calcium values were computed from smoothed TDS values and correlation between observed calcium and TDS concentrations. Smoothed values correspond with observed values in all three subregions as shown in Figs. B-7, B-8 and B-9. Smoothed calcium concentrations vary between 22-55 mg/L in the North subregion, 43-122 mg/L in the West subregion, and 41-87 mg/L in the South subregion.

Chloride

Monthly chloride values were computed from smoothed TDS values and correlation between observed chloride and TDS concentrations. Smoothed values correspond with observed values in all three subregions as shown in Figs. B-10, B-11 and B-12. Smoothed calcium concentrations vary between 22-55 mg/L in the North subregion, 43-122 mg/L in the West subregion, and 41-87 mg/L in the South subregion.

Electrical Conductivity (EC)

Monthly EC values were computed from smoothed TDS values and correlation between observed EC and TDS concentrations. Smoothed values correspond with observed values in all three subregions as shown in Figs. B-13, B-14 and B-15. Smoothed ECs vary between 340-821 µS/cm in the North subregion, 941-1892 µS/cm in the West subregion, and 720-1352 µS/cm in the South subregion.

Magnesium

Monthly magnesium values were computed from smoothed TDS values and correlation between observed magnesium and TDS concentrations. Smoothed values correspond with observed values in all three subregions as shown in Figs. B-16, B-17 and B-18. Smoothed magnesium concentrations vary between 15-43 mg/L in the North subregion, 28-72 mg/L in the West subregion, and 22-45 mg/L in the South subregion. It is interesting to note similar concentration ranges in the North and South subregions.

Sodium

Monthly sodium values were computed from smoothed TDS values and correlation between observed sodium and TDS concentrations. Smoothed values correspond with observed values in all three subregions as shown in Figs. B-19, B-20 and B-21. Smoothed sodium concentrations vary between 27-60 mg/L in the North subregion, 106-180 mg/L in the West subregion, and 73-123 mg/L in the South subregion.

Sulfate

Monthly sulfate values were computed from smoothed TDS values and correlation between observed sulfate and TDS concentrations. Smoothed values correspond with observed values in all three subregions as shown in Figs. B-22, B-23 and B-24. Smoothed sulfate concentrations vary between 18-119 mg/L in the North subregion, 66-406 mg/L in the West subregion, and 71-124 mg/L in the South subregion.

Internal Checks

Several internal checks of the smoothed data were made, including (1) comparing computed and measured TDS concentration, (2) comparing the cation and anion sum, and (3) comparing the cation sum and EC estimate.

If all constituents are accounted for, a calculated TDS value (the sum of mineral concentrations) should theoretically equal measured TDS concentration. But according to Hem (1985), computed TDS may differ from measured TDS by 10-20 mg/L when the solids concentration is in the order of 100-500 mg/L. It is not uncommon for waters high in calcium and sulfate to have measured TDS concentrations several hundred mg/L greater than computed values. Hem concludes that oftentimes, especially if the solids concentration is greater than 1000 mg/L, the calculated TDS value may be preferred to the measured TDS value. Absence of dissolved silica measurements in the MWQI data is another source of difference between calculated and measured TDS. Natural waters commonly contain between 1-30 mg/L silica (*JMM 1985*). DWR (*Sacramento 1991*) reported dissolved silica concentrations between 15-20 mg/L in Sacramento River water at Greens Landing during 1991. It is therefore reasonable to expect total mineral concentrations to be consistently less than measured TDS concentrations, and possibly some predictable fraction of TDS. This expectation was used in Table 4 as one criteria for checking consistency between raw and smoothed monthly values. For the North subregion, aggregated MWQI data showed the mineral sum to be 13-26% lower than the measured TDS concentration. Smoothing results in the mineral sum being 21% less than the TDS concentration. For the West subregion, aggregated MWQI data showed the mineral sum to be 10-12% lower than the measured TDS concentration.

Table 4. TDS and Total Mineral Concentration Comparison (mg/L): MWQI & Smoothed Values

AREA	MONTH	OBSERVED TDS	OBSERVED MINERALS	DIFF (%)	SMOOTHED TDS	SMOOTHED MINERALS	DIFF (%)
North	Jan	554	441	-20	578	458	-21
North	Feb	572	442	-23	586	464	-21
North	Mar	593	475	-20	562	445	-21
North	Apr	468	380	-19	457	362	-21
North	May	333	270	-19	300	237	-21
North	Jun	299	235	-21	256	202	-21
North	Jul	248	192	-23	228	180	-21
North	Aug	275	205	-26	256	202	-21
North	Sep	234	203	-13	300	237	-21
North	Oct	406	328	-19	357	282	-21
North	Nov	345	259	-25	420	333	-21
North	Dec	397	309	-22	500	396	-21
West	Jan	1020	913	-10	1062	950	-11
West	Feb	1355	1208	-11	1288	1152	-11
West	Mar	-----	-----	-----	1128	1009	-11
West	Apr	830	735	-12	915	818	-11
West	May	-----	-----	-----	695	621	-11
West	Jun	600	539	-10	582	520	-11
West	Jul	541	486	-10	556	497	-11
West	Aug	527	469	-11	569	508	-11
West	Sep	-----	-----	-----	610	545	-11
West	Oct	625	552	-12	670	599	-11
West	Nov	-----	-----	-----	750	670	-11
West	Dec	-----	-----	-----	900	805	-11
South	Jan	798	706	-11	847	714	-16
South	Feb	817	752	-8	799	679	-15
South	Mar	884	698	-21	771	658	-15
South	Apr	665	612	-8	666	579	-13
South	May	562	504	-10	514	465	-9
South	Jun	538	478	-11	464	428	-8
South	Jul	515	454	-12	438	409	-7
South	Aug	473	421	-11	426	399	-6
South	Sep	-----	-----	-----	473	435	-8
South	Oct	702	619	-12	530	477	-10
South	Nov	-----	-----	-----	600	530	-12
South	Dec	537	453	-16	707	610	-14

Smoothing results in the mineral sum being 11% less than the TDS concentration. For the South subregion, aggregated MWQI data showed the mineral sum to be 8-21% lower than the measured TDS concentration. Smoothing results in the mineral sum being 6-16% lower than the TDS concentration.

The sum of positively charged minerals (cations) should theoretically equal the sum of negatively charged minerals (anions) to maintain ion charge neutrality, where concentrations are expressed in equivalent units. Charge neutrality was used as a second internal check between raw and smoothed monthly values. The cation and anion sums shown in Table 5 do not account for minor constituents. The cation sum includes calcium, magnesium and sodium; the anion sum includes alkalinity, chloride and sulfate. For the North subregion, aggregated MWQI data showed the cation sum to be 3-10% higher than the anion sum. Smoothing results in the cation sum being 2-7% higher than the anion sum. For the West subregion, MWQI data showed the cation sum to be 0-4% higher than the anion sum. Smoothing results in the cation sum being 1-2% higher than the anion sum. For the South subregion, MWQI data showed the cation sum to be -2 to 8% higher than the anion sum. Smoothing results in the cation sum being -4 to 7% higher than the anion sum.

As reported by Hem (1985), the cation or anion sum (100 x meq/L) approximately equals EC in µS/cm. Parsimony between cation sum and EC was used as a third internal check between raw and smoothed monthly values. EC is also included in Table 5 for comparison with the cation sum. For the North subregion, aggregated MWQI data showed the cation sum to be 0-16% higher than EC. Smoothing results in the cation sum being 4-9% higher than EC. For the West subregion, aggregated MWQI data showed the cation sum to be -5 to 7% higher than EC. Smoothing results in the cation sum being -4 to 5% higher than EC. For the South subregion, aggregated MWQI data showed the cation sum to be -6 to 3% higher than EC. Smoothing results in the cation sum being -3 to -1% higher than EC.

Mineral Ratios

Variability in agricultural return ionic makeup results from differences in irrigation water characteristics as well as differences in soil-water interactions. Four mineral ratios (in mass concentration units) were calculated from smoothed monthly values: the Ca:Mg ratio; the Na:Cl ratio; the (Na+Cl):TDS ratio; and the SO_4:TDS ratio. In surface waters, high Ca:Mg and Na:Cl ratios usually indicate a land-based mineral source while high (Na+Cl):TDS ratios usually indicate a marine mineral source. High SO_4:TDS ratios generally indicate the presence of a pollution source.

Smoothed monthly Ca:Mg ratios range between 1.3-1.5 in the North Delta and 1.5-1.7 in the West Delta. The ratio is approximately 1.9 in the South Delta. Since North Delta islands irrigate with fresh water, the Ca:Mg ratio was expected to be the highest among the three subregions. The expected trend in ion ratios may have been

Table 5. Charge Balance Comparison (meq/L): MWQI & Smoothed Values

AREA	MONTH	OBSERVED CATIONS	OBSERVED ANIONS	DIFF (%)	OBSERVED EC	SMOOTH CATIONS	SMOOTH ANIONS	DIFF (%)	SMOOTH EC
North	Jan	8.41	7.78	8	779	8.80	8.20	7	809
North	Feb	8.31	7.81	6	769	8.92	8.31	7	821
North	Mar	9.43	8.56	10	847	8.56	7.98	7	788
North	Apr	7.18	6.91	4	696	6.99	6.56	6	648
North	May	5.39	5.11	5	463	4.61	4.43	4	436
North	Jun	4.49	4.28	5	447	3.96	3.83	3	378
North	Jul	3.64	3.51	4	362	3.54	3.45	2	340
North	Aug	4.04	3.75	8	388	3.95	3.83	3	377
North	Sep	4.02	3.86	4	383	4.62	4.43	4	437
North	Oct	6.41	6.20	3	615	5.47	5.20	5	513
North	Nov	5.18	5.02	3	447	6.42	6.06	6	598
North	Dec	5.86	5.61	5	564	7.63	7.14	7	705
West	Jan	15.91	15.74	1	1609	16.50	16.17	2	1598
West	Feb	20.77	20.05	4	1940	19.83	19.38	2	1892
West	Mar	-----	-----	---	-----	17.48	17.11	2	1685
West	Apr	13.06	12.80	2	1304	14.33	14.08	2	1407
West	May	-----	-----	---	-----	11.09	10.95	1	1121
West	Jun	9.73	9.63	1	997	9.42	9.34	1	974
West	Jul	8.77	8.68	1	899	9.04	8.97	1	941
West	Aug	8.49	8.48	0	889	9.23	9.15	1	957
West	Sep	-----	-----	---	-----	9.84	9.74	1	1011
West	Oct	10.15	9.89	3	1040	10.72	10.59	1	1089
West	Nov	-----	-----	---	-----	11.90	11.73	1	1193
West	Dec	-----	-----	---	-----	14.11	13.87	2	1388
South	Jan	12.75	12.44	3	1262	13.38	12.48	7	1352
South	Feb	13.30	13.62	-2	1412	12.67	11.90	6	1281
South	Mar	13.33	12.34	8	1290	12.24	11.55	6	1239
South	Apr	11.01	11.02	0	1144	10.65	10.27	4	1081
South	May	9.24	9.14	1	956	8.35	8.41	-1	852
South	Jun	8.64	8.51	2	878	7.60	7.81	-3	779
South	Jul	8.24	8.06	2	826	7.21	7.49	-4	739
South	Aug	7.75	7.52	3	780	7.02	7.33	-4	720
South	Sep	-----	-----	---	-----	7.73	7.91	-2	791
South	Oct	11.26	11.15	1	1152	8.60	8.61	0	877
South	Nov	-----	-----	---	-----	9.65	9.46	2	982
South	Dec	8.30	7.99	4	835	11.27	10.77	5	1142

damped by prevailing ion exchange reactions in the soils (*K. Tanji pers. comm., 1995*).

Smoothed monthly Na:Cl ratios are approximately 0.8 in the North Delta, 0.6 in the West Delta, and range between 0.5-0.7 in the South Delta. Smoothed monthly (Na+Cl):TDS ratios range between 0.2-0.3 in the North Delta and 0.4-0.5 in the West Delta; the ratio is approximately 0.4 in the South Delta. These mineral ratios are consistent with expected irrigation water quality applied to the three subregions.

C-034561

CARBON

Carbon-based water quality constituents include dissolved organic carbon (DOC), ultraviolet absorbance at 254 nm (UV-254), THM formation potential as carbon (TFPC), and carbonaceous biochemical oxygen demand (BOD). Excepting BOD, monthly values are based on aggregated MWQI data. These data are spatially distributed by DOC subregion. BOD, based on Table 20 of Bulletin 123, are spatially distributed by Bulletin 123 subregion. Raw data were not available to redistribute the BOD values according to DOC subregion. Smoothed monthly carbon-based values are summarized in Table 6.

Dissolved Organic Carbon (DOC)

DOC is a well-accepted surrogate measure of organic disinfection by-product precursor concentration. Monthly DOC values, shown in Fig. 5, were smoothed by inspection to approximate continuous changes in concentration over time. Unsmoothed data are also shown for comparison. In the high- and mid-DOC subregions, maximum concentrations are observed in the winter (January) and minimum concentrations are observed in the summer. This temporal variation is probably related to salt leaching practices in the Delta lowlands. As shown in Fig. 5, smoothed values range between 17-34 mg/L in the high-DOC subregion and 9-22 mg/L in the mid-DOC subregion. The low-DOC subregion, located in the Delta uplands, exhibits an opposite temporal trend, with maximum concentrations occuring in the summer and minimum concentrations occuring in the winter. Smoothed values range between 4-8 mg/L in the low-DOC subregion.

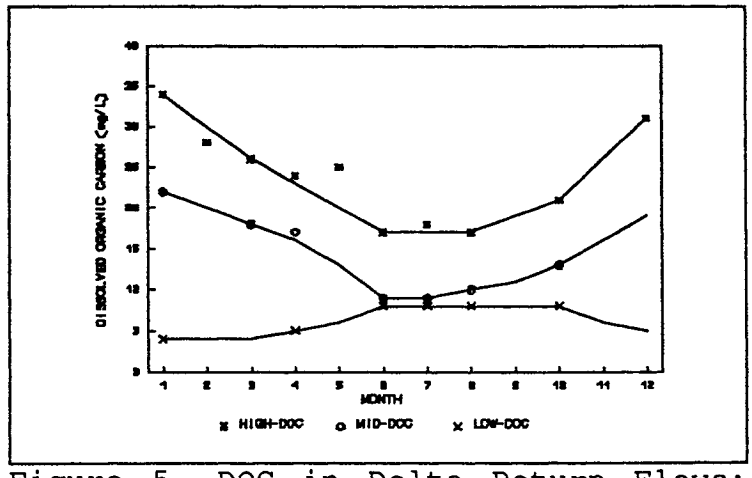

Figure 5. DOC in Delta Return Flows: Smoothed and Unsmoothed Monthly Values by Subregion

Ultraviolet Absorbance (UV-254)

Ultraviolet absorbance at 254 nm is a measure of the reactivity of organic material in forming disinfection by-products and is often strongly correlated with DOC. Insufficient data was available to develop representative monthly UV-254 values. Therefore, monthly UV-254 values were computed from smoothed monthly DOC values with the aid of linear regression equations given in Appendix A

Table 6. Smoothed Monthly Carbon Values

DOC AREA	MONTH	DOC (mg/L)	TFPC (µg/L)	UV254 (cm^{-1})	BOD (mg/L)	BOD AREA
Low	Jan	4	42	0.118	5.2	North
Low	Feb	4	42	0.118	5.7	North
Low	Mar	4	42	0.118	5.2	North
Low	Apr	5	52	0.135	4.4	North
Low	May	6	62	0.152	3.8	North
Low	Jun	8	83	0.185	3.1	North
Low	Jul	8	83	0.185	2.5	North
Low	Aug	8	83	0.185	2.2	North
Low	Sep	8	83	0.185	2.6	North
Low	Oct	8	83	0.185	3.5	North
Low	Nov	6	62	0.152	4.1	North
Low	Dec	5	52	0.135	4.7	North
Mid	Jan	22	229	1.050	5.2	West
Mid	Feb	20	208	0.953	5.7	West
Mid	Mar	18	187	0.856	5.2	West
Mid	Apr	16	166	0.760	4.4	West
Mid	May	13	135	0.615	3.8	West
Mid	Jun	9	94	0.422	3.1	West
Mid	Jul	9	94	0.422	2.5	West
Mid	Aug	10	104	0.470	2.2	West
Mid	Sep	11	114	0.518	2.6	West
Mid	Oct	13	135	0.615	3.5	West
Mid	Nov	16	166	0.760	4.1	West
Mid	Dec	19	198	0.905	4.7	West
High	Jan	34	354	1.499	7.7	South
High	Feb	30	312	1.334	8.2	South
High	Mar	26	270	1.170	7.7	South
High	Apr	23	239	1.047	7.1	South
High	May	20	208	0.923	6.0	South
High	Jun	17	177	0.800	5.1	South
High	Jul	17	177	0.800	4.1	South
High	Aug	17	177	0.800	4.0	South
High	Sep	19	198	0.882	4.5	South
High	Oct	21	218	0.965	5.2	South
High	Nov	26	270	1.170	6.0	South
High	Dec	31	322	1.375	7.0	South

(*MWQI 1995*). The regression equations show relatively high UV-254 to DOC ratios in high-DOC subregion and relatively low ratios in low-DOC subregion, suggesting that organics in the former subregion are most likely to act as disinfection by-product precursors. As shown in Fig. 6, monthly values range between 0.80-1.50 cm^{-1} in the high-DOC subregion, 0.42-1.05 cm^{-1} in the mid-DOC subregion, and 0.12-0.18 cm^{-1} in the low-DOC subregion.

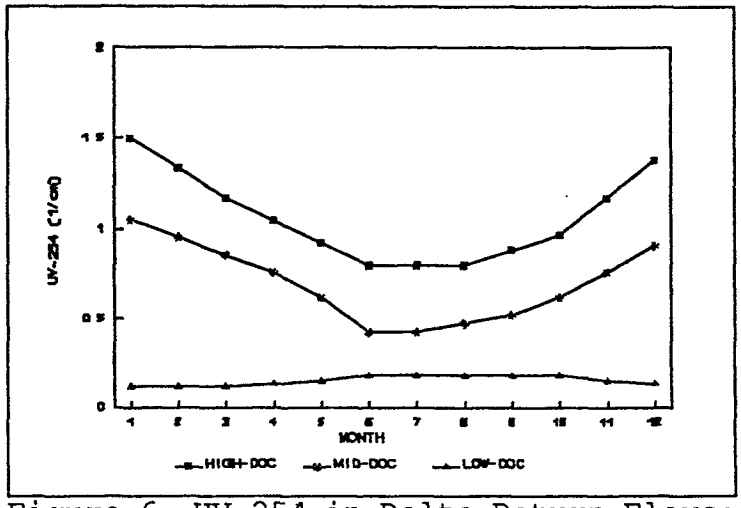

Figure 6. UV-254 in Delta Return Flows: Smoothed Monthly Values by Subregion

THM Formation Potential Carbon (TFPC)

TFPC is a specific measure of the organic THM precursor content in a water. DWR found that its TFPC measurements taken on high-DOC waters are artificially low due to insufficient chlorine addition (*Five-Year 1994*). To rectify the problem of artificially low values, TFPC concentrations reported in Appendix A were re-computed from smoothed monthly DOC values with the aid of a simple correlation between TFPC and DOC (TFPC = 10.4 x DOC) when DOC was less than 20 mg/L. See Fig. 7. As shown in Fig. 8, smoothed monthly TFPC values range between 177-354 µg/L in the high- DOC subregion, 94-229 µg/L in the mid-DOC subregion, and 42-83 µg/L in the low-DOC subregion. Raw data are also shown for comparison in Fig. 8. The smoothed TFPC values associated with the high-DOC subregion often deviate significantly from unsmoothed data due to measurement problems discussed above. *Due to these measurement problems and other considerations, TFPC is considered to be inferior to DOC and UV-254 as a Delta organic precursor transport constituent.*

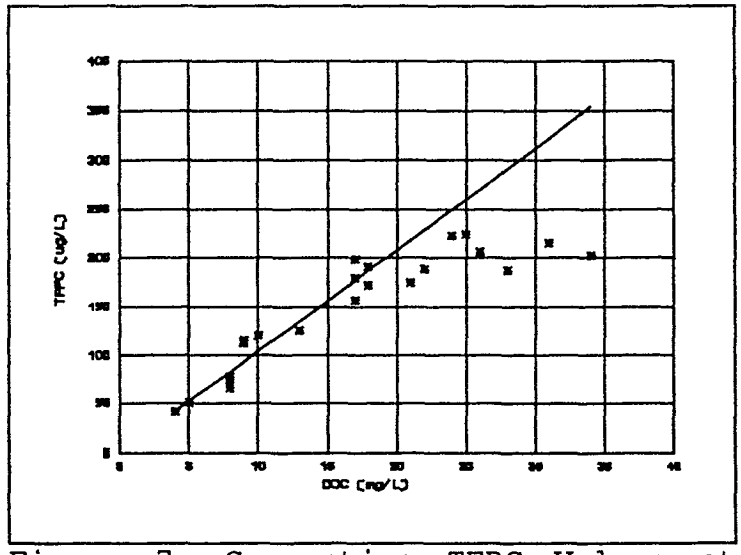

Figure 7. Correcting TFPC Values at High DOC Concentrations

Carbonaceous Biochemical Oxygen Demand (BOD)

Monthly BOD values were smoothed by inspection to approximate continuous changes over time. Smoothed values, shown in Fig. 9, are identical for the North and West subregions. Spatially, BOD concentrations are higher in the South subregion and lower in the North and West subregions. Temporally, BOD concentrations reach a maximum in winter (February) and reach a minimum in the summer (August). Unsmoothed values from Table 20 of Bulletin 123 are also shown for comparison.

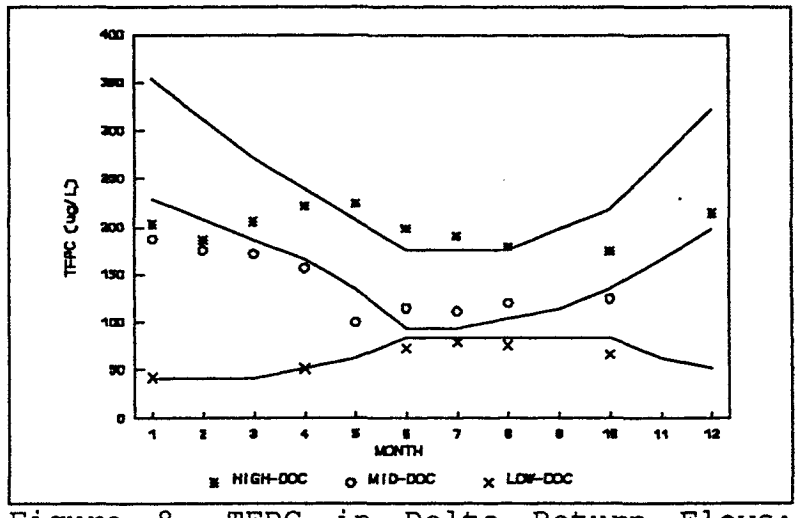

Figure 8. TFPC in Delta Return Flows: Smoothed and Unsmoothed Monthly Values by Subregion

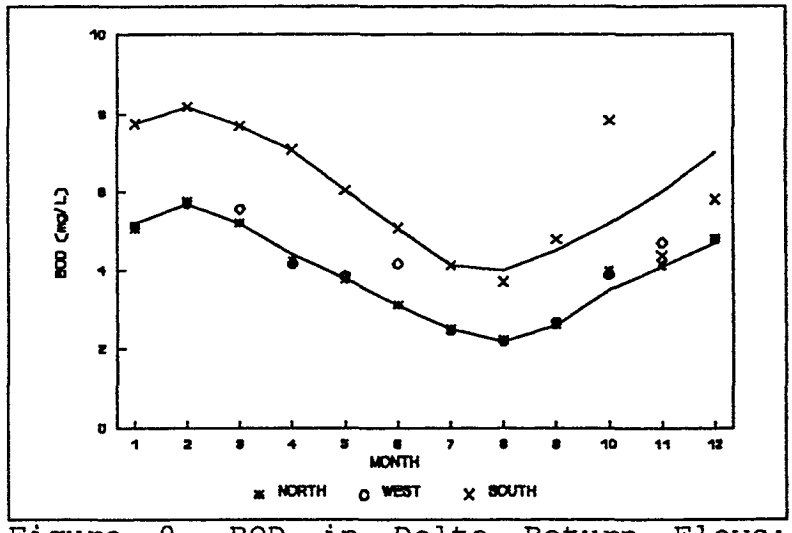

Figure 9. BOD in Delta Return Flows: Smoothed and Unsmoothed Monthly Values by Subregion

NUTRIENTS

Nitrogen and phosphorus concentrations were not routinely measured by the MWQI program. Therefore, monthly nutrient values were based on Bulletin 123 data. Accordingly, spatial distribution follows that defined by Bulletin 123. Information is not available to assess uncertainty in monthly nutrient estimates.

Nitrogen Species

Monthly total nitrogen values shown in Fig. 10 were smoothed by inspection to approximate continuous changes over time. Unsmoothed data are also shown for comparison. In general, total nitrogen concentrations are highest in the South subregion and lowest in the North subregion. Within each subregion, total nitrogen concentrations reach maximums in late winter or early spring and reach minimums in the summer.

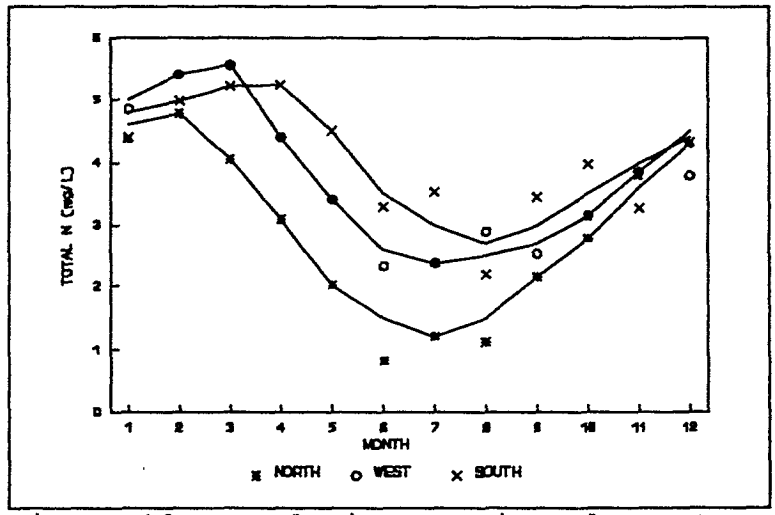

Figure 10. Total Nitrogen in Delta Return Flows: Smoothed and Unsmoothed Values by Subregion

Nitrogen speciation is assumed to be constant both spatially and temporally and is based on simple unweighted averages of data reported in Table 18 of Bulletin 123. Organic nitrogen is assumed to be 50% of the smoothed total nitrogen concentrations, nitrite nitrogen is assumed to be 1% of the smoothed total nitrogen concentrations, nitrate nitrogen is assumed to be 39% of the smoothed total nitrogen concentrations, and ammonia nitrogen is assumed to be 10% of the smoothed total nitrogen concentrations. The preceding assumptions result in monthly average values ranging between 0.6-2.8 mg/L for organic nitrogen, 0.01-0.04 mg/L for nitrite nitrogen, 0.5-2.2 mg/L for nitrate nitrogen, and 0.13-0.58 mg/L for ammonia nitrogen. Smoothed monthly nitrogen values are summarized in Table 7.

Phosphorus Species

Bulletin 123 did not attempt to develop monthly average phosphorus concentrations. Based on simple unweighted averages of data reported in Table 18 of Bulletin 123, total phosphorus concentration is assumed to be 10% of the total

nitrogen concentration and phosphorus speciation is assumed to be 67% inorganic and 33% organic. The nitrogen to phosphorus ratio is consistent with typical natural waters (*JMM 1985*). These assumptions result in the monthly values given in Table 8. Inorganic phosphorus concentrations range between 0.08-0.37 mg/L and organic phosphorus concentrations range between 0.04-0.19 mg/L.

Table 7. Smoothed Monthly Nutrient Concentrations (mg/L as N or P)

AREA	MONTH	ORGANIC N	NITRITE N	NITRATE N	AMMONIA N	INORGANIC P	ORGANIC P
North	Jan	2.3	0.04	1.8	0.48	0.31	0.15
North	Feb	2.4	0.04	1.9	0.50	0.32	0.16
North	Mar	2.0	0.03	1.6	0.43	0.27	0.14
North	Apr	1.5	0.02	1.2	0.32	0.21	0.10
North	May	1.0	0.02	0.8	0.21	0.13	0.07
North	Jun	0.8	0.01	0.6	0.16	0.10	0.05
North	Jul	0.6	0.01	0.5	0.13	0.08	0.04
North	Aug	0.8	0.01	0.6	0.16	0.10	0.05
North	Sep	1.1	0.02	0.8	0.23	0.14	0.07
North	Oct	1.4	0.02	1.1	0.29	0.19	0.09
North	Nov	1.8	0.03	1.4	0.38	0.24	0.12
North	Dec	2.2	0.03	1.7	0.45	0.29	0.14
West	Jan	2.5	0.04	1.9	0.52	0.33	0.17
West	Feb	2.7	0.04	2.1	0.57	0.36	0.18
West	Mar	2.8	0.04	2.2	0.58	0.37	0.19
West	Apr	2.2	0.03	1.7	0.46	0.29	0.15
West	May	1.7	0.03	1.3	0.36	0.23	0.11
West	Jun	1.3	0.02	1.0	0.27	0.17	0.09
West	Jul	1.2	0.02	0.9	0.25	0.16	0.08
West	Aug	1.3	0.02	1.0	0.26	0.17	0.08
West	Sep	1.4	0.02	1.0	0.28	0.18	0.09
West	Oct	1.6	0.02	1.2	0.33	0.21	0.11
West	Nov	1.9	0.03	1.5	0.40	0.26	0.13
West	Dec	2.3	0.04	1.7	0.47	0.30	0.15
South	Jan	2.4	0.04	1.9	0.50	0.32	0.16
South	Feb	2.5	0.04	1.9	0.52	0.33	0.17
South	Mar	2.6	0.04	2.0	0.55	0.35	0.17
South	Apr	2.6	0.04	2.0	0.55	0.35	0.17
South	May	2.2	0.04	1.7	0.47	0.30	0.15
South	Jun	1.8	0.03	1.4	0.37	0.23	0.12
South	Jul	1.5	0.02	1.2	0.31	0.20	0.10
South	Aug	1.4	0.02	1.0	0.28	0.18	0.09
South	Sep	1.5	0.02	1.2	0.31	0.20	0.10
South	Oct	1.8	0.03	1.4	0.37	0.23	0.12
South	Nov	2.0	0.03	1.5	0.42	0.27	0.13
South	Dec	2.2	0.03	1.7	0.46	0.29	0.15

C-034568

MISCELLANEOUS

Miscellaneous water quality constituents include chlorophyll-a, dissolved oxygen, pH, and temperature. Excepting chlorophyll-a, monthly values are based on aggregated MWQI data. As there are no immediate plans to model hydrogen ion fate and movement in the Delta, pH values are provided for reference only. Smoothed monthly values for chlorophyll-a, dissolved oxygen and temperature are given in Table 8. These miscellaneous constituents are subject to considerable diurnal variation; however, no attempt has been made in this report to characterize this variability.

Dissolved Oxygen

Dissolved oxygen concentration varies spatially by DOC subregion, with high oxygen concentrations associated with the low-DOC subregion and low oxygen concentrations associated with the high-DOC subregion. Data were smoothed by inspection to approximate continuous changes in concentration over time. Temporal variation is easily explained by an inverse relationship between dissolved oxygen and temperature; maximum concentrations are observed in the winter (February) and minimum concentrations are observed in the summer (September). As shown in Fig 11, smoothed values vary between 6.3-9.7 mg/L in the low-DOC subregion, 5.4-7.4 mg/L in the mid-DOC subregion, and 3.9-7.0 mg/L in the high-DOC subregion. Unsmoothed data are also shown for comparison.

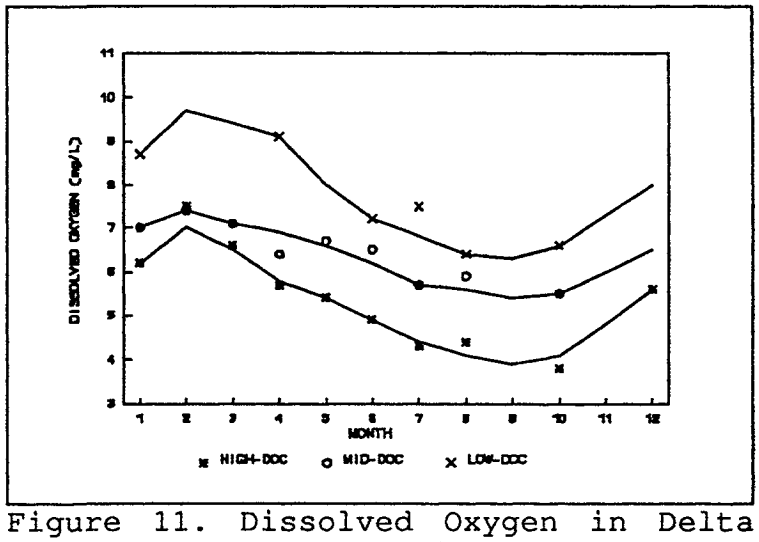

Figure 11. Dissolved Oxygen in Delta Return Flows: Smoothed and Unsmoothed Values by Subregion

Table 8. Smoothed Monthly Miscellaneous Values

DO/TEMP AREA	MONTH	CHLOROPHYLL-A (µg/L)	DISSOLVED OXYGEN (mg/L)	TEMP (°C)	CHL-A AREA
Low	Jan	2	8.7	9.5	North
Low	Feb	2	9.7	10.0	North
Low	Mar	2	9.4	12.5	North
Low	Apr	3	9.1	16.0	North
Low	May	3	8.0	19.0	North
Low	Jun	3	7.2	21.0	North
Low	Jul	2	6.8	23.0	North
Low	Aug	1	6.4	23.5	North
Low	Sep	1	6.3	20.5	North
Low	Oct	1	6.6	17.0	North
Low	Nov	1	7.3	12.5	North
Low	Dec	1	8.0	11.0	North
Mid	Jan	1	7.0	9.5	West
Mid	Feb	1	7.4	10.0	West
Mid	Mar	1	7.1	12.5	West
Mid	Apr	3	6.9	16.0	West
Mid	May	8	6.6	19.0	West
Mid	Jun	10	6.2	21.0	West
Mid	Jul	10	5.7	23.0	West
Mid	Aug	10	5.6	23.5	West
Mid	Sep	8	5.4	20.5	West
Mid	Oct	6	5.5	17.0	West
Mid	Nov	4	6.0	12.5	West
Mid	Dec	1	6.5	11.0	West
High	Jan	6	6.2	9.5	South
High	Feb	6	7.0	10.0	South
High	Mar	10	6.5	12.5	South
High	Apr	17	5.8	16.0	South
High	May	23	5.4	19.0	South
High	Jun	27	4.9	21.0	South
High	Jul	31	4.4	23.0	South
High	Aug	30	4.1	23.5	South
High	Sep	25	3.9	20.5	South
High	Oct	12	4.1	17.0	South
High	Nov	8	4.8	12.5	South
High	Dec	6	5.6	11.0	South

pH

The aggregated MWQI data did not demonstrate distinct spatial or seasonal pattern in pH. A median value of 7.1 appears to be reasonable, with upper and lower quartile variation of about ± 0.3. This data is provided for reference only, as there are no immediate plans to model hydrogen ion fate and movement in the Delta.

Temperature

Temperature does not vary significantly by DOC subregion. Therefore, all drains were assigned a single monthly temperature value. These values were smoothed by inspection to approximate continuous changes in temperature over time. As shown in Fig 12, values vary from a minimum of 9.5 °C in January to a maximum of 23.5 °C in August. Unsmoothed data are also shown for comparison.

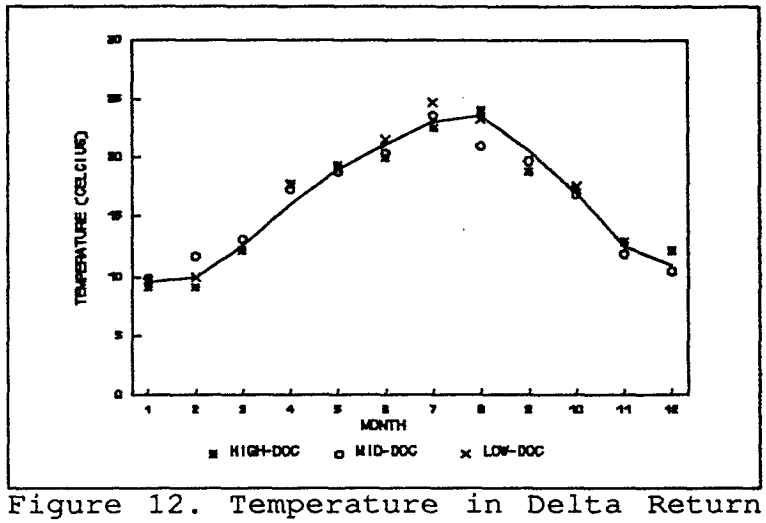

Figure 12. Temperature in Delta Return Flows: Smoothed and Unsmoothed Values by Subregion

Chlorophyll-a

Chlorophyll-a data for agricultural return flows were not available for this study. Therefore, smoothed monthly values were developed from data collected by DWR's Environmental Services Office between 1978-90. Data collected at Greens Landing (station C3) were used to represent drains in the North Delta, data collected at Jersey Point (station D15) used to represent drains in the West Delta, and data collected at Vernalis (station C10) were used to represent drains in the South Delta. Duplicate data were not included in the analysis. Smoothed monthly estimates should be revised as data becomes available for agricultural drains.

Chlorophyll-a concentrations vary by Bulletin 123 subregion, with high concentrations associated with the South Delta and low concentrations associated with the North Delta. Data were smoothed by inspection to approximate continuous changes in concentration over time. Temporal variation is directly related to seasonal temperature changes, with maximum concentrations occuring in the summer and minimum concentrations occuring in the winter. As shown in Fig. 13, smoothed values vary between 1-3 µg/L in the North, 1-10 µg/L in the West, and 6-31 µg/L in the South. Unsmoothed data are also shown for comparison.

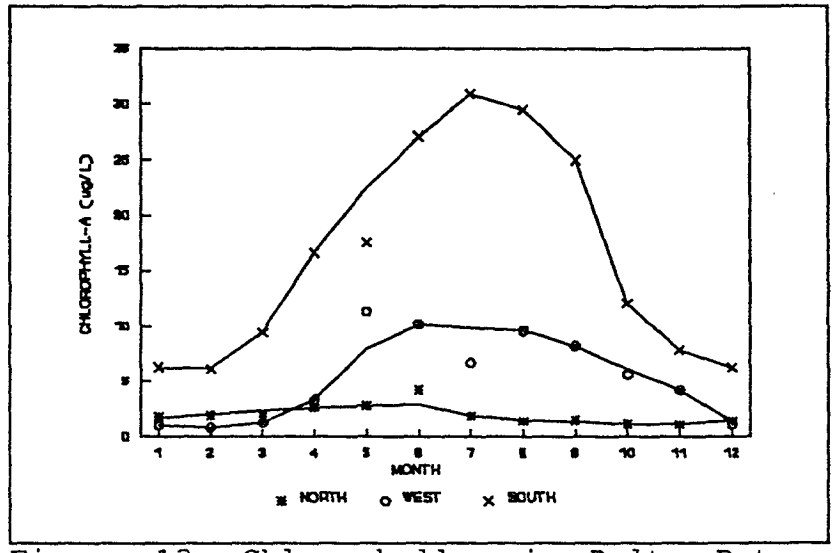

Figure 13. Chlorophyll-a in Delta Return Flows: Smoothed and Unsmoothed Values by Subregion

UNCERTAINTY IN MONTHLY DOC & UV-254 ESTIMATES

Given the scarcity (in both space and time) of available agricultural return quality data, realized values will vary substantially from monthly estimates. Appendix A provides some quantification of variability associated with the aggregated MWQI data via lower and upper quartile values. Wide variability provides a justification to adjust return qualities within a reasonable range of uncertainty, such that a better overall fit between DSM2-simulated and observed values is achieved throughout the Delta. For return quality to be a useful calibration parameter, at least two conditions must be met. First, important locations in the Delta must be sensitive to changes in return quality. Second, reasonable ranges of uncertainty must be established.

Organic constituents such as DOC and UV-254 are considered to meet the above conditions. Therefore, lower and upper bounds for these constituents were developed from lower and upper quartile values in Appendix A (see Table 9). *Bounds were not established for TFPC as it is considered to be an inferior Delta organic precursor transport constituent.*

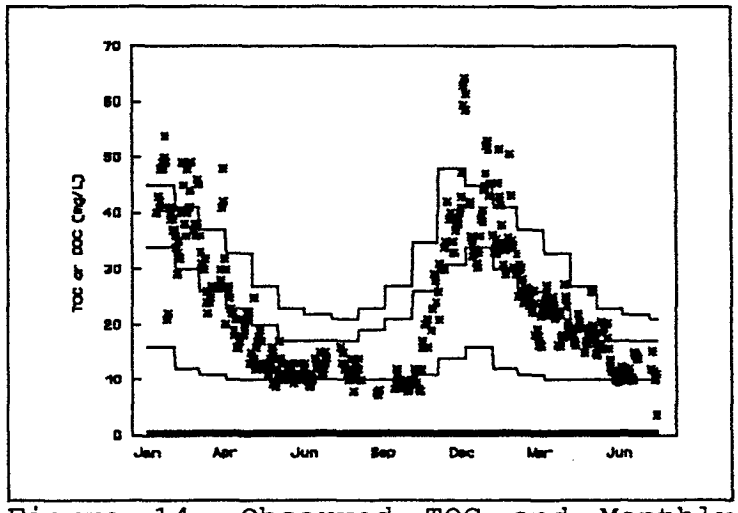

Figure 14. Observed TOC and Monthly Representative DOC at Mandeville Pumping Plant #1: 1993-94 MWQI Autosample Data

Monthly high-DOC values, along with upper and lower bounds from Table 9, are plotted along with daily TOC data measured by MWQI at Mandeville Pumping Plant #1 (Fig. 14) and at Twitchell Island (Fig. 15). These figures show a reasonably good correspondence between observed concentrations and representative bounds. However, note that Fig. 3 classifies Mandeville Island in the mid-DOC subregion. Fig. 14 suggests that Mandeville Island is better represented as a high-DOC island.

Table 9. Range of DOC and UV-254 Estimates

AREA	MONTH	Low DOC Estimate (mg/L)	High DOC Estimate (mg/L)	Low UV-254 Estimate (cm^{-1})	High UV-254 Estimate (cm^{-1})
Low	Jan	3.0	4.0	0.10	0.12
Low	Feb	3.5	4.5	0.11	0.13
Low	Mar	4.0	5.0	0.12	0.13
Low	Apr	4.5	5.5	0.13	0.14
Low	May	5.0	7.0	0.13	0.17
Low	Jun	5.5	8.5	0.14	0.19
Low	Jul	6.0	9.5	0.15	0.21
Low	Aug	6.0	10.0	0.15	0.22
Low	Sep	6.0	10.0	0.15	0.22
Low	Oct	5.0	10.0	0.13	0.22
Low	Nov	4.0	8.0	0.12	0.18
Low	Dec	3.0	6.0	0.10	0.15
Mid	Jan	12.0	28.0	0.57	1.34
Mid	Feb	12.0	27.0	0.57	1.29
Mid	Mar	12.0	26.0	0.57	1.24
Mid	Apr	10.0	24.0	0.47	1.15
Mid	May	8.0	17.0	0.37	0.81
Mid	Jun	6.0	11.0	0.28	0.52
Mid	Jul	5.0	12.0	0.23	0.57
Mid	Aug	4.0	14.0	0.18	0.66
Mid	Sep	5.0	16.0	0.23	0.76
Mid	Oct	6.0	19.0	0.28	0.91
Mid	Nov	8.0	22.0	0.37	1.05
Mid	Dec	10.0	27.0	0.47	1.29
High	Jan	16.0	45.0	0.76	1.95
High	Feb	12.0	41.0	0.59	1.79
High	Mar	11.0	37.0	0.55	1.62
High	Apr	10.0	33.0	0.51	1.46
High	May	10.0	27.0	0.51	1.21
High	Jun	10.0	23.0	0.51	1.05
High	Jul	10.0	22.0	0.51	1.01
High	Aug	10.0	21.0	0.51	0.96
High	Sep	10.0	23.0	0.51	1.05
High	Oct	10.0	27.0	0.51	1.21
High	Nov	11.0	35.0	0.55	1.54
High	Dec	14.0	48.0	0.68	2.07

Interquartile values are also available in Appendix A for minerals, EC, dissolved oxygen and temperature. Lower and upper bounds were not developed for these constituents, however.

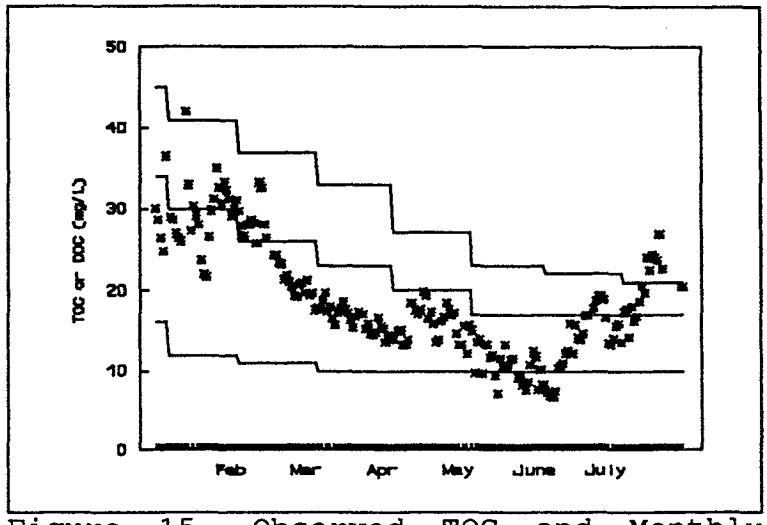

Figure 15. Observed TOC and Monthly Representative DOC at Twitchell Island Pumping Plant: 1994 MWQI Autosample Data

INPUT

Smoothed monthly values for minerals, EC, carbon constituents, nutrients, and miscellaneous constituents are assigned to DSM2 nodes corresponding to each node's location in the Delta. Appendix C tabulates the Bulletin 123 subregion and DOC subregion corresponding with each DSM2 node.

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APPENDIX A

AGGREGATE MWQI DATA STATISTICS

OFFICE MEMO

TO: Paul Hutton	DATE: February 1, 1995
	SUBJECT: MWQI Data Request
FROM: Rick Woodard	

Attached are the data you requested from the MWQI Program. The attached data are preliminary and have not undergone quality assessment by the MWQI Program staff. Therefore, the data should be used for internal purposes only. Please call Collette Zemitis at 327-1685 or me at 327-1636 if you have any questions.

Attachments

1. Memo from Marvin Jung
2. Summary statistics for MWQI data

cc: Judy Heath
Marvin Jung
Collette Zemitis

MEMORANDUM

TO: Collette Zemitis

FROM: Marvin Jung

January 24, 1995

DATA FOR PAUL HUTTON'S REQUEST

Attached are the data that Paul Hutton requested for use in the new DSM2 computer model. The data consists of monthly statistics for bromide, calcium, chloride, dissolved oxygen, DOC, EC, magnesium, sodium, sulfate, temperature, TFPC, THMFP, TOC, and UVA at the low range, midrange, and high range DOC regions of the Delta as illustrated and described in the MWQI Five-Year Summary Report, 1987-91. The data set covered all records through October 1993.

Monthly statistics for some months could not be computed for some parameters at some regions because no samples were collected at those times.

Please forward the data to him and inform Rick about the transmittal of this data to Paul. Paul had also requested that I perform regression analyses to fill in the missing monthly data. My preliminary analyses show that regression results may not be sufficiently definintive to estimate monthly water quality from other parameters. This is likely due to the stochastic nature of water quality. At this time, I would recommend Paul conduct an interpolation of the data to obtain the missing monthly statistics as there may be better serial correlation and seasonal trends among the observations than straight-forward mathematical regressions.

Since I am working on analyzing the standard minerals data since 1982 for a new MWQI report and to develop a recommendation on continuance of such analyses in the MWQI program, I will have the opportunity to examine the data in greater detail.

Summary Statistics for do (HIGH POC REGION ~~RANGE~~)

mo	Count	Average	Median
1	122	6.22459	6.2
2	37	7.51351	7.4
3	20	6.595	6.45
4	117	5.73846	5.7
5	25	5.412	5.8
6	88	4.94318	4.9
7	104	4.28942	4.4
8	83	4.39759	4.2
9	6	3.55	3.8
10	83	3.81687	3.3
11	9	5.53333	5.3
12	27	5.64074	5.7
Total	721	5.21817	5.0

mo	Geometric mean	Minimum	Maximum
1	5.76275	1.4	11.8
2	6.99186	2.1	12.9
3	5.85811	1.0	11.7
4	5.04454	0.1	12.9
5	4.66625	1.1	8.7
6	4.64859	1.9	10.3
7	3.72825	0.4	10.1
8	4.04722	1.5	13.1
9	3.32358	2.0	5.2
10	3.41961	0.6	8.7
11	5.06506	2.3	9.0
12	5.29513	1.7	10.6
Total	4.63537	0.1	13.1

mo	Range	Lower quartile	Upper quartile
1	10.4	4.6	7.5
2	10.8	5.4	9.5
3	10.7	4.4	8.55
4	12.8	3.9	7.3
5	7.6	4.2	7.5
6	8.4	3.75	5.95
7	9.7	3.0	5.35
8	11.6	3.1	5.4
9	3.2	2.0	4.5
10	8.1	2.4	4.9
11	6.7	4.2	8.1
12	8.9	3.9	7.1
Total	13.0	3.6	6.6

Summary Statistics for doc (HIGH DOC REGION)

mo	Count	Average	Median
1	100	33.912	34.0
2	30	28.2	25.5
3	2	59.0	59.0
4	97	24.2938	22.0
5	20	25.355	19.0
6	82	17.4134	14.0
7	101	18.201	17.0
8	89	17.082	16.0
9	3	48.6667	32.0
10	64	20.7016	15.5
11	6	38.6667	37.0
12	9	58.8889	56.0
Total	603	23.6123	19.0

mo	Geometric mean	Minimum	Maximum
1	27.1174	4.1	100.0
2	21.7834	4.3	68.0
3	57.7668	47.0	71.0
4	20.0657	3.1	89.0
5	19.311	5.7	83.0
6	14.5852	3.7	54.0
7	15.544	3.5	76.0
8	14.8088	3.5	57.0
9	38.0976	18.0	96.0
10	16.7037	6.4	75.0
11	33.2479	12.0	66.0
12	55.9285	29.0	94.0
Total	18.6966	3.1	100.0

mo	Range	Lower quartile	Upper quartile
1	95.9	16.5	44.5
2	63.7	9.9	36.0
3	24.0	47.0	71.0
4	85.9	13.0	33.0
5	77.3	10.3	31.0
6	50.3	10.0	23.0
7	72.5	11.0	22.0
8	83.5	10.0	21.0
9	78.0	18.0	96.0
10	68.6	9.65	26.5
11	54.0	24.0	56.0
12	65.0	51.0	60.0
Total	96.9	11.0	30.0

Summary Statistics for temp (HIGH DOC REGIONS)

mo	Count	Average	Median
1	120	9.09333	9.2
2	36	9.09722	9.8
3	39	12.1974	14.0
4	118	17.8475	18.0
5	26	19.3462	19.0
6	87	20.0115	20.0
7	109	22.3853	22.0
8	92	24.0326	22.0
9	6	18.8333	19.0
10	84	17.4881	17.0
11	9	12.9111	13.0
12	27	12.1778	13.0
Total	753	17.1612	18.0

mo	Geometric mean	Minimum	Maximum
1	8.93156	5.6	14.0
2	8.23596	2.0	14.0
3		0.0	20.0
4		0.0	60.0
5	19.2655	16.0	23.0
6	19.9022	16.0	25.0
7	22.3035	19.0	29.0
8	22.5406	17.0	200.0
9	18.7763	17.0	21.0
10	17.4159	14.0	22.0
11	12.4406	7.0	16.0
12	11.7809	5.0	17.0
Total		0.0	200.0

mo	Range	Lower quartile	Upper quartile
1	8.4	7.8	10.0
2	12.0	6.6	12.0
3	20.0	11.0	15.0
4	60.0	16.0	19.0
5	7.0	18.0	20.0
6	9.0	19.0	21.0
7	10.0	21.0	24.0
8	183.0	21.0	23.0
9	4.0	17.0	20.0
10	8.0	16.0	19.0
11	9.0	9.9	16.0
12	12.0	11.0	14.0
Total	200.0	13.0	21.0

Summary Statistics for tfpc (HIGH DOC REGION)

mo	Count	Average	Median
1	111	203.369	210.0
2	35	186.8	190.0
3	38	206.447	215.0
4	104	222.038	220.0
5	24	223.583	225.0
6	80	198.65	170.0
7	109	191.083	180.0
8	92	180.228	180.0
9	6	321.667	335.0
10	84	174.643	150.0
11	9	271.111	280.0
12	26	215.731	245.0
Total	718	199.673	190.0

mo	Geometric mean	Minimum	Maximum
1	178.697	47.0	730.0
2	158.251	29.0	380.0
3	173.887	39.0	450.0
4	185.241	16.0	500.0
5	195.004	66.0	510.0
6	162.079	39.0	920.0
7	169.279	41.0	900.0
8	160.769	11.0	370.0
9	313.554	220.0	440.0
10	142.295	9.0	630.0
11	251.858	140.0	540.0
12	191.415	42.0	320.0
Total	170.485	9.0	920.0

mo	Range	Lower quartile	Upper quartile
1	683.0	130.0	260.0
2	351.0	110.0	260.0
3	411.0	97.0	300.0
4	484.0	130.0	300.0
5	442.0	125.0	290.0
6	891.0	92.0	265.0
7	859.0	120.0	230.0
8	359.0	130.0	225.0
9	220.0	250.0	350.0
10	621.0	89.0	215.0
11	400.0	210.0	280.0
12	276.0	170.0	280.0
Total	911.0	120.0	260.0

Summary Statistics for toc (HIGH DOC REGION)

mo	Count	Average	Median
1	19	33.6263	32.0
2	4	68.0	72.0
3	30	25.8733	20.0
4	17	20.3118	14.0
5	4	44.5	36.0
6	2	17.0	17.0
7	6	24.55	16.5
8	1	34.0	34.0
9	2	26.0	26.0
10	18	24.6278	13.0
11	2	40.5	40.5
12	17	31.0882	26.0
Total	122	28.9385	23.0

mo	Geometric mean	Minimum	Maximum
1	24.3045	4.7	100.0
2	67.4641	54.0	74.0
3	19.7511	4.9	74.0
4	15.1801	3.4	64.0
5	38.1535	20.0	86.0
6	15.4919	10.0	24.0
7	18.5861	7.3	71.0
8	34.0	34.0	34.0
9	24.7386	18.0	34.0
10	16.601	6.0	96.0
11	28.775	12.0	69.0
12	23.1632	4.2	65.0
Total	21.0019	3.4	100.0

mo	Range	Lower quartile	Upper quartile
1	95.3	9.8	55.0
2	20.0	63.0	73.0
3	69.1	11.0	37.0
4	60.6	9.0	26.0
5	66.0	24.0	65.0
6	14.0	10.0	24.0
7	63.7	13.0	23.0
8	0.0	34.0	34.0
9	16.0	18.0	34.0
10	90.0	8.9	22.0
11	57.0	12.0	69.0
12	60.8	14.0	48.0
Total	96.6	11.0	41.0

Summary Statistics for uva (HIGH DOC REGION)

po	Count	Average	Median
1	58	1.49483	1.5
3	79	1.08481	1.0
5	53	0.820755	0.7
7	78	0.802564	0.7
8	65	0.826154	0.8
10	61	0.955738	0.8
Total	394	0.991117	0.8

mo	Geometric mean	Minimum	Maximum
1	1.21147	0.2	3.5
4	0.881603	0.1	3.1
6	0.67776	0.2	2.8
7	0.690205	0.1	3.9
8	0.718809	0.2	2.5
10	0.793544	0.2	3.2
Total	0.80814	0.1	3.9

mo	Range	Lower quartile	Upper quartile
1	3.3	1.0	1.9
4	3.0	0.5	1.5
6	2.6	0.5	1.0
7	3.8	0.5	1.0
8	2.3	0.5	1.1
10	3.0	0.6	1.2
Total	3.8	0.5	1.3

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Summary Statistics for DO (MID-DOC REGION)

MO	Count	Average	Median
1	23	7.04783	7.3
2	10	7.4	7.95
3	15	7.14	7.8
4	22	6.41818	6.6
5	11	6.65455	6.7
6	25	6.524	6.5
7	23	5.65652	5.7
8	17	5.9	6.4
9	8	5.3625	5.35
10	18	5.48889	5.65
11	9	6.68889	7.0
12	9	8.13333	9.1
Total	190	6.45368	6.5

MO	Geometric mean	Minimum	Maximum
1	6.7808	3.3	9.2
2	7.13027	4.4	9.4
3	7.01718	4.2	8.8
4	6.19635	3.0	11.0
5	6.57783	4.7	8.2
6	6.44686	4.6	9.3
7	5.14	0.5	9.5
8	5.67701	2.2	7.6
9	5.23545	3.0	6.8
10	5.26165	2.6	7.2
11	6.50656	4.4	8.6
12	7.63156	3.7	11.0
Total	6.17146	0.5	11.0

MO	Range	Lower quartile	Upper quartile
1	5.9	5.4	8.2
2	5.0	5.5	8.8
3	4.6	6.4	8.0
4	8.0	5.4	7.3
5	3.5	6.0	7.4
6	4.7	5.7	7.0
7	9.0	5.0	6.5
8	5.4	5.4	6.7
9	3.8	5.1	6.1
10	4.6	4.7	6.7
11	4.2	5.8	8.1
12	7.3	8.1	9.2
Total	10.5	5.4	7.6

MO	Interquartile range
1	2.8
2	3.3
3	1.6
4	1.9
5	1.4
6	1.3
7	1.5
8	1.3
9	1.0
10	2.0
11	2.3
12	1.1
Total	2.2

Summary Statistics for DOC (MID-DOC REGION)

	Count	Average	Median
1	16	22.475	17.0
	4	16.25	18.0
	3	11.7	5.7
	13	16.8154	11.0
5	5	6.54	5.6
6	16	8.60625	6.9
	18	9.39444	7.85
	16	10.3625	7.0
	3	8.4	8.5
10	16	12.7375	11.0
11	5	12.88	12.0
12	3	14.6667	14.0
Total	118	12.8898	10.0

	Geometric mean	Minimum	Maximum
	18.537	6.3	61.0
2	15.7394	10.0	19.0
	9.03982	5.4	24.0
	14.1991	7.0	38.0
	6.24854	4.2	10.0
6	8.0612	5.8	17.0
7	7.91631	3.0	26.0
	7.99811	3.1	26.0
	8.10766	5.7	11.0
10	10.2811	4.0	34.0
11	9.49496	1.7	26.0
12	14.6372	14.0	16.0
Total	10.2629	1.7	61.0

MO	Range	Lower quartile	Upper quartile
	54.7	10.5	28.5
	9.0	13.5	19.0
3	18.6	5.4	24.0
4	31.0	10.0	24.0
	5.8	5.4	7.5
	11.2	6.2	9.65
	25.0	4.8	12.0
8	22.9	3.8	14.0
9	5.3	5.7	11.0
10	30.0	6.25	16.0
11	24.3	9.7	15.0
12	3.0	14.0	16.0
Total	59.3	6.2	16.0

MO	Interquartile range
1	16.0
2	5.5
3	18.6
4	14.0
5	2.1
6	3.45
7	7.2
8	10.2
9	5.3
10	9.75
11	5.3
12	2.0
Total	9.8

Summary Statistics for TEMP (MID-DOC REGION)

MO	Count	Average	Median
1	23	9.68261	9.8
2	10	11.66	11.5
3	17	13.1647	13.0
4	22	17.1591	17.0
5	11	18.6	18.2
6	25	20.228	20.2
7	23	23.4391	23.5
8	20	20.98	20.85
9	8	19.7	19.2
10	23	16.8522	16.7
11	9	11.8778	13.1
12	9	10.5222	10.6
Total	200	16.782	17.15

MO	Geometric mean	Minimum	Maximum
1	9.4884	6.0	13.5
2	11.4178	9.3	17.5
3	12.8863	8.2	19.5
4	17.0724	14.0	20.9
5	18.518	16.8	22.5
6	20.0525	15.8	25.0
7	23.3422	19.9	26.9
8	20.909	18.4	23.9
9	19.6527	18.5	23.1
10	16.8077	14.4	19.0
11	11.5162	6.0	14.5
12	10.396	7.4	13.0
Total	15.9667	6.0	26.9

MO	Range	Lower quartile	Upper quartile
1	7.5	8.0	11.0
2	8.2	9.5	12.5
3	11.3	12.0	13.0
4	6.9	16.3	18.2
5	5.7	17.0	19.0
6	9.2	19.1	21.2
7	7.0	22.0	25.4
8	5.8	19.4	22.45
9	4.6	18.6	20.0
10	4.6	16.0	17.8
11	8.5	9.9	13.5
12	5.6	10.0	10.8
Total	20.9	13.0	20.25

MO	Interquartile range
1	3.0
2	3.0
3	1.0
4	1.9
5	2.0
6	2.1
7	3.4
8	3.05
9	1.2
10	1.8
11	3.6
12	0.8
Total	7.25

Summary Statistics for TFPC (MID-DOC REGION)

MO	Count	Average	Median
1	23	187.783	200.0
2	10	175.8	195.0
3	21	172.048	150.0
4	20	157.35	140.0
5	11	100.364	83.0
6	23	115.0	97.0
7	22	112.364	98.0
8	20	119.75	95.5
9	8	129.625	120.0
10	23	125.478	110.0
11	9	169.111	130.0
12	8	212.5	185.0
Total	198	144.434	120.0

MO	Geometric mean	Minimum	Maximum
1	170.055	76.0	360.0
2	162.57	72.0	250.0
3	147.795	46.0	380.0
4	147.665	91.0	290.0
5	93.9849	64.0	190.0
6	107.23	48.0	240.0
7	94.2668	16.0	260.0
8	103.06	39.0	300.0
9	110.03	27.0	230.0
10	111.878	46.0	280.0
11	136.641	33.0	430.0
12	198.068	130.0	400.0
Total	125.467	16.0	430.0

MO	Range	Lower quartile	Upper quartile
1	284.0	110.0	230.0
2	178.0	140.0	220.0
3	334.0	91.0	210.0
4	199.0	120.0	195.0
5	126.0	68.0	110.0
6	192.0	85.0	140.0
7	244.0	64.0	160.0
8	261.0	70.5	140.0
9	203.0	95.0	175.0
10	234.0	85.0	140.0
11	397.0	95.0	210.0
12	270.0	145.0	255.0
Total	414.0	87.0	200.0

MO	Interquartile range
1	120.0
2	80.0
3	119.0
4	85.0
5	42.0
6	55.0
7	96.0
8	69.5
9	80.0
10	55.0
11	115.0
12	110.0
Total	113.0

Summary Statistics for TOC (MID-DOC REGION)

MO	Count	Average	Median
1	5	22.4	24.0
2	4	20.25	20.0
3	11	17.8364	18.0
4	6	9.9	8.9
5	3	6.8	6.0
6	5	6.22	5.8
7	1	1.4	1.4
8	1	5.6	5.6
9	1	7.8	7.8
10	5	10.92	8.0
11	2	13.5	13.5
12	4	15.25	13.5
Total	48	13.6979	12.5

MO	Geometric mean	Minimum	Maximum
1	21.877	15.0	29.0
2	20.0993	17.0	24.0
3	13.7338	1.9	36.0
4	9.54436	7.1	14.0
5	6.63126	5.4	9.0
6	6.17793	5.5	7.6
7	1.4	1.4	1.4
8	5.6	5.6	5.6
9	7.8	7.8	7.8
10	9.76755	6.3	20.0
11	13.4907	13.0	14.0
12	14.6083	11.0	23.0
Total	11.2092	1.4	36.0

MO	Range	Lower quartile	Upper quartile
1	14.0	20.0	24.0
2	7.0	18.5	22.0
3	34.1	6.3	28.0
4	6.3	7.5	13.0
5	3.6	5.4	9.0
6	2.1	5.9	6.4
7	0.0	1.4	1.4
8	0.0	5.6	5.6
9	0.0	7.8	7.8
10	13.7	6.3	14.0
11	1.0	13.0	14.0
12	12.0	11.5	19.0
Total	34.6	6.35	20.0

MO	Interquartile range
1	4.0
2	3.5
3	21.7
4	5.5
5	3.6
6	0.6
7	0.0
8	0.0
9	0.0
10	7.7
11	1.0
12	7.5
Total	13.65

Summary Statistics for UVA (MID-DOC REGION)

MO	Count	Average	Median
[illegible]	9	1.24444	0.7
[illegible]1	10	0.78	0.5
[illegible]6	11	0.427273	0.3
7	14	0.492857	0.4
[illegible]8	12	0.633333	0.5
[illegible]10	12	0.733333	0.55
Total	68	0.691176	0.5

MO	Geometric mean	Minimum	Maximum
1	0.972108	0.4	2.9
4	0.659445	0.3	1.8
6	0.391447	0.3	0.9
7	0.405513	0.2	1.4
8	0.490004	0.2	1.5
10	0.511915	0.2	2.1
Total	0.523839	0.2	2.9

MO	Range	Lower quartile	Upper quartile
[illegible]1	2.5	0.6	1.7
[illegible]4	1.5	0.4	1.2
[illegible]6	0.6	0.3	0.6
[illegible]7	1.2	0.2	0.7
[illegible]8	1.3	0.25	0.95
[illegible]10	1.9	0.2	1.1
[illegible]Total	2.7	0.3	0.85

MO	Interquartile range
[illegible]1	1.1
[illegible]4	0.8
[illegible]6	0.3
7	0.5
[illegible]8	0.7
[illegible]10	0.9
Total	0.55

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Summary Statistics for do (LOW DOC REGION)

mo	Count	Average	Median
1	18	8.74444	8.8
2	1	9.7	9.7
4	14	9.07857	8.8
5	2	11.0	11.0
6	13	7.24615	7.1
7	19	7.52632	8.5
8	12	6.35833	6.45
10	14	6.59286	5.95
Total	93	7.76344	7.5

mo	Geometric mean	Minimum	Maximum
1	8.64526	6.7	11.0
2	9.7	9.7	9.7
4	8.50069	4.1	17.0
5	10.9545	10.0	12.0
6	7.14514	5.0	9.3
7	7.12967	3.0	10.0
8	6.18595	3.1	8.3
10	6.24678	3.6	13.0
Total	7.40885	3.0	17.0

mo	Range	Lower quartile	Upper quartile
1	4.3	7.5	10.0
2	0.0	9.7	9.7
4	12.9	7.2	9.9
5	2.0	10.0	12.0
6	4.3	6.7	8.2
7	7.0	5.2	9.4
8	5.2	5.65	7.1
10	9.4	5.4	7.4
Total	14.0	6.3	9.0

mo	Interquartile range
1	2.5
2	0.0
4	2.7
5	2.0
6	1.5
7	4.2
8	1.45
10	2.0
Total	2.7

Summary Statistics for DOC (LOW DOC REGION)

	Count	Average	Median
1	15	3.68	3.0
	1	6.2	6.2
	10	5.13	4.9
	2	4.5	4.5
6	13	7.69231	6.6
7	19	7.83158	7.5
	12	7.925	6.95
	11	8.25455	7.7
Total	83	6.70361	6.2

	Geometric mean	Minimum	Maximum
1	3.47443	2.2	6.8
2	6.2	6.2	6.2
	5.09147	4.4	6.5
	4.5	4.5	4.5
	7.07402	4.1	18.0
7	7.53255	4.5	13.0
	7.62364	5.9	14.0
	7.72461	4.5	14.0
Total	6.12685	2.2	18.0

	Range	Lower quartile	Upper quartile
	4.6	2.7	4.2
2	0.0	6.2	6.2
	2.1	4.5	5.6
	0.0	4.5	4.5
	13.9	5.0	8.5
	8.5	5.9	9.5
8	8.1	6.2	8.35
0	9.5	5.0	12.0
Total	18.8	4.8	7.7

MO	Interquartile range
	1.5
2	0.0
4	1.1
	0.0
	3.5
	3.6
8	2.15
10	7.0
Total	2.9

Summary Statistics for TEMP (LOW DOC REGION)

MO	Count	Average	Median
1	18	9.66667	9.25
2	1	10.0	10.0
4	16	17.7062	17.05
5	2	19.05	19.05
6	13	21.5308	21.4
7	19	24.7263	22.0
8	12	23.225	22.95
10	14	17.5786	17.55
Total	95	18.7358	19.8

MO	Geometric mean	Minimum	Maximum
1	9.34792	6.3	13.8
2	10.0	10.0	10.0
4	17.5848	14.7	20.5
5	19.0421	18.5	19.6
6	21.5042	19.8	23.3
7	24.2603	19.2	34.5
8	23.17	21.0	25.9
10	17.531	15.3	20.2
Total	17.6252	6.3	34.5

MO	Range	Lower quartile	Upper quartile
1	7.5	7.3	12.0
2	0.0	10.0	10.0
4	5.8	16.0	19.8
5	1.1	18.5	19.6
6	3.5	21.1	21.7
7	15.3	20.7	29.5
8	4.9	22.2	24.45
10	4.9	16.9	18.2
Total	28.2	15.7	22.0

MO	Interquartile range
1	4.7
2	0.0
4	3.8
5	1.1
6	0.6
7	8.8
8	2.25
10	1.3
Total	6.3

Summary Statistics for TFPC (LOW DOC REGION)

MO	Count	Average	Median
1	15	41.6	33.0
2	1	43.0	43.0
3	1	76.0	76.0
4	13	51.4615	54.0
5	2	58.5	58.5
6	10	71.7	62.0
7	19	77.7368	71.0
8	12	74.75	72.0
10	14	65.7857	61.0
Total	87	63.6897	60.0

MO	Geometric mean	Minimum	Maximum
1	37.4487	20.0	85.0
2	43.0	43.0	43.0
3	76.0	76.0	76.0
4	50.4059	34.0	69.0
5	57.3585	47.0	70.0
6	67.7429	44.0	130.0
7	75.6688	55.0	100.0
8	68.2957	27.0	130.0
10	62.0618	37.0	110.0
Total	58.7219	20.0	130.0

MO	Range	Lower quartile	Upper quartile
1	65.0	24.0	62.0
2	0.0	43.0	43.0
3	0.0	76.0	76.0
4	38.0	45.0	60.0
5	23.0	47.0	70.0
6	86.0	56.0	74.0
7	45.0	58.0	98.0
8	103.0	56.5	85.0
10	73.0	47.0	85.0
Total	110.0	45.0	79.0

MO	Interquartile range
1	38.0
2	0.0
3	0.0
4	15.0
5	23.0
6	18.0
7	40.0
8	28.5
10	38.0
Total	34.0

Summary Statistics for TOC (LOW DOC REGION)

MO	Count	Average	Median
1	3	7.73333	7.2
4	6	7.6	4.8
10	3	7.36667	7.5
Total	12	7.575	7.0

MO	Geometric mean	Minimum	Maximum
1	7.66555	6.8	9.2
4	6.42843	3.8	16.0
10	7.3197	6.3	8.3
Total	6.93923	3.8	16.0

MO	Range	Lower quartile	Upper quartile
1	2.4	6.8	9.2
4	12.2	4.2	12.0
10	2.0	6.3	8.3
Total	12.2	4.8	8.75

MO	Interquartile range
1	2.4
4	7.8
10	2.0
Total	3.95

Summary Statistics for UVA (LOW DOC REGION)

MO	Count	Average	Median
1	6	0.136667	0.135
4	6	0.115	0.12
6	9	0.196667	0.19
7	15	0.204	0.19
8	9	0.167778	0.16
10	11	0.178182	0.17
Total	56	0.175179	0.17

MO	Geometric mean	Minimum	Maximum
1	0.130677	0.08	0.19
4	0.114441	0.1	0.13
6	0.183165	0.11	0.34
7	0.197234	0.12	0.29
8	0.165494	0.13	0.22
10	0.167952	0.1	0.27
Total	0.16572	0.08	0.34

MO	Range	Lower quartile	Upper quartile
1	0.11	0.1	0.18
4	0.03	0.1	0.12
6	0.23	0.12	0.23
7	0.17	0.15	0.24
8	0.09	0.15	0.19
10	0.17	0.11	0.24
Total	0.26	0.125	0.21

MO	Interquartile range
1	0.08
4	0.02
6	0.11
7	0.09
8	0.04
10	0.13
Total	0.085

State of California DEPARTMENT OF WATER RESOURCES The Resources Age...y

OFFICE MEMO

TO: Paul Hutton	DATE: February 15, 1995
	SUBJECT: MWQI Data Request
FROM: Rick Woodard	

Attached are the data you requested from the MWQI Program. These data have not been quality assessed and should be used internally. If you have any questions, please call me at 327-1636. Thank you.

Attachments

1. Transmittal memorandum from Marvin Jung
2. Statistical analyses

cc: Judy Heath
Raymond Tom
Marvin Jung
Collette Zemitis

MEMORANDUM

TO: Collette Zemitis, DWR DLA

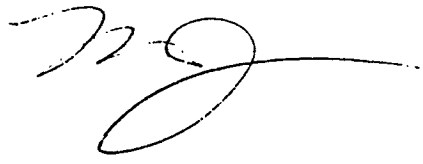
FROM: Marvin Jung

February 13, 1995

STATISTICAL DATA REQUESTED BY PAUL HUTTON, DELTA MODELING SECTION

Attached are the revised statistical analyses that were requested by Paul Hutton last week. He requested monthly descriptive statistics of alkalinity, bromide, chloride, calcium, EC, magnesium, pH, sulfate, and TDS for each of the three Delta regions (North, Southeast, and West) as designated in DWR Bulletin 123. He also asked for linear regression results for DOC vs. UVA at each of the three DOC regions (low, mid, and high DOC concentration range).

Please forward the data to Paul and make a copy for me. Also inform Rick and Judy that I have met Paul's request.



Summary Statistics for alk

ND (North Delta)

no	Count	Average	Median
1	57	149.351	141.0
2	12	162.167	165.5
3	15	211.267	171.0
4	49	144.02	119.0
5	14	153.857	98.5
6	47	97.4468	88.0
7	55	82.8545	74.0
8	38	93.1579	83.5
9	4	125.0	117.0
10	35	169.943	143.0
11	6	170.0	153.5
12	15	134.533	136.0
Total	347	129.689	107.0

no	Minimum	Maximum	Lower quartile
1	31.0	376.0	118.0
2	73.0	354.0	112.5
3	88.0	461.0	101.0
4	56.0	374.0	98.0
5	68.0	441.0	88.0
6	36.0	229.0	67.0
7	46.0	244.0	61.0
8	56.0	184.0	71.0
9	98.0	168.0	107.0
10	79.0	530.0	93.0
11	149.0	234.0	153.0
12	62.0	247.0	111.0
Total	31.0	530.0	78.0

no	Upper quartile
1	173.0
2	188.5
3	251.0
4	180.0
5	151.0
6	110.0
7	85.0
8	106.0
9	143.0
10	222.0
11	177.0
12	150.0
Total	156.0

Summary Statistics for br ND

[redacted]	Count	Average	Median
1	23	0.314348	0.3
[redacted]	1	0.18	0.18
[redacted]	22	0.392727	0.31
[redacted]	19	0.261579	0.23
7	32	0.165625	0.15
[redacted]	26	0.210923	0.13
[redacted]	22	0.395	0.35
Total	145	0.279269	0.23

[redacted]	Minimum	Maximum	Lower quartile
[redacted]	0.13	0.71	0.21
2	0.18	0.18	0.18
[redacted]	0.13	1.26	0.21
[redacted]	0.08	0.51	0.14
[redacted]	0.02	0.41	0.095
[redacted]	0.046	0.54	0.08
10	0.08	0.84	0.18
[redacted]otal	0.02	1.26	0.14

[redacted]mo	Upper quartile
[redacted]	0.37
[redacted]	0.18
[redacted]	0.46
6	0.37
7	0.17
[redacted]	0.36
[redacted]0	0.58
Total	0.37

Summary Statistics for ca ND

mo	Count	Average	Median
1	55	51.6727	50.0
2	12	55.1667	49.5
3	15	56.2	56.0
4	49	44.2449	38.0
5	14	32.9286	20.0
6	47	27.7021	23.0
7	54	23.2778	18.0
8	38	25.8684	19.5
9	4	24.25	25.5
10	35	38.0571	32.0
11	6	32.8333	32.5
12	15	38.1333	35.0
Total	344	36.9651	32.0

mo	Minimum	Maximum	Lower quartile
1	21.0	101.0	38.0
2	33.0	107.0	41.5
3	20.0	134.0	35.0
4	16.0	101.0	32.0
5	14.0	85.0	17.0
6	10.0	99.0	19.0
7	11.0	80.0	15.0
8	12.0	94.0	16.0
9	19.0	27.0	21.5
10	16.0	93.0	24.0
11	23.0	46.0	27.0
12	26.0	60.0	32.0
Total	10.0	134.0	20.0

mo	Upper quartile
1	59.0
2	64.0
3	72.0
4	50.0
5	38.0
6	31.0
7	23.0
8	27.0
9	27.0
10	44.0
11	36.0
12	42.0
Total	47.0

[redacted]

[redacted]mary Statistics for cl ND

	Count	Average	Median
[redacted]	60	82.8333	72.0
[redacted]	15	69.0	62.0
[redacted]	26	63.5385	49.5
4	53	82.7358	53.0
5	17	39.1765	23.0
[redacted]	51	52.4706	31.0
[redacted]	57	39.4561	25.0
[redacted]	50	44.0	26.0
9	7	27.4286	31.0
[redacted]	37	69.2432	40.0
[redacted]	9	33.0	25.0
[redacted]	18	49.9444	42.5
Total	400	59.4575	40.5

	Minimum	Maximum	Lower quartile
1	22.0	239.0	45.5
[redacted]	27.0	161.0	35.0
[redacted]	7.0	219.0	42.0
[redacted]	14.0	354.0	28.0
[redacted]	8.0	195.0	13.0
6	9.0	237.0	16.0
[redacted]	7.0	190.0	16.0
[redacted]	7.0	229.0	15.0
[redacted]	12.0	41.0	20.0
10	15.0	236.0	24.0
11	12.0	103.0	20.0
[redacted]	18.0	117.0	24.0
[redacted]tal	7.0	354.0	22.0

	Upper quartile
[redacted]	109.0
[redacted]	84.0
3	76.0
[redacted]	92.0
[redacted]	44.0
[redacted]	75.0
7	50.0
[redacted]	39.0
[redacted]	33.0
[redacted]	92.0
[redacted]	34.0
12	62.0
[redacted]tal	79.5

Summary Statistics for ec ND

mo	Count	Average	Median
1	60	779.2	714.0
2	15	769.0	647.0
3	26	847.423	804.0
4	53	696.321	582.0
5	17	462.882	320.0
6	51	447.078	379.0
7	57	362.421	299.0
8	50	388.14	302.5
9	7	382.571	369.0
10	37	615.189	531.0
11	9	446.667	441.0
12	18	564.167	579.0
Total	400	568.938	494.5

mo	Minimum	Maximum	Lower quartile
1	372.0	1460.0	579.0
2	478.0	1300.0	576.0
3	187.0	1820.0	543.0
4	257.0	1680.0	480.0
5	201.0	1250.0	278.0
6	158.0	1470.0	285.0
7	137.0	1220.0	236.0
8	177.0	1390.0	248.0
9	264.0	499.0	354.0
10	263.0	1470.0	369.0
11	237.0	804.0	376.0
12	366.0	829.0	430.0
Total	137.0	1820.0	315.0

mo	Upper quartile
1	955.0
2	876.0
3	1080.0
4	765.0
5	463.0
6	500.0
7	410.0
8	379.0
9	451.0
10	821.0
11	467.0
12	649.0
Total	707.0

Summary Statistics for mg ND

mo	Count	Average	Median
1	55	38.8727	36.0
[redacted]	12	37.1667	36.5
[redacted]	15	50.9333	42.0
[redacted]	49	31.898	24.0
5	14	27.7143	13.5
[redacted]	47	18.2128	15.0
[redacted]	54	15.1111	12.0
[redacted]	38	17.2368	12.0
[redacted]	4	19.0	19.0
10	35	28.9429	22.0
[redacted]	6	25.5	22.5
[redacted]	15	26.2667	25.0
Total	344	26.9244	22.0

mo	Minimum	Maximum	Lower quartile
[redacted]	12.0	111.0	25.0
2	18.0	53.0	29.5
[redacted]	16.0	163.0	23.0
[redacted]	10.0	116.0	20.0
[redacted]	8.0	96.0	12.0
6	6.0	73.0	11.0
7	5.0	57.0	9.0
[redacted]	7.0	64.0	10.0
[redacted]	12.0	26.0	15.0
[redacted]0	10.0	100.0	15.0
11	21.0	42.0	22.0
[redacted]2	16.0	47.0	20.0
Total	5.0	163.0	12.0

mo	Upper quartile
[redacted]	45.0
[redacted]	46.0
3	72.0
[redacted]4	35.0
[redacted]	25.0
[redacted]	20.0
[redacted]	16.0
8	19.0
[redacted]	23.0
[redacted]10	35.0
[redacted]11	23.0
12	30.0
Total	33.5

Summary Statistics for na ND

mo	Count	Average	Median
1	60	60.3333	55.5
2	15	58.2	45.0
3	26	56.0769	50.5
4	53	54.2075	46.0
5	17	32.5294	23.0
6	51	37.451	32.0
7	56	29.4107	24.5
8	50	30.66	25.0
9	7	29.1429	25.0
10	37	48.7297	40.0
11	9	31.8889	30.0
12	18	41.8333	38.0
Total	399	43.8947	38.0

mo	Minimum	Maximum	Lower quartile
1	24.0	146.0	41.0
2	35.0	114.0	42.0
3	12.0	105.0	44.0
4	16.0	154.0	33.0
5	14.0	72.0	18.0
6	10.0	127.0	21.0
7	8.0	84.0	17.0
8	12.0	91.0	19.0
9	19.0	44.0	24.0
10	18.0	110.0	27.0
11	18.0	55.0	28.0
12	25.0	75.0	33.0
Total	8.0	154.0	25.0

mo	Upper quartile
1	73.5
2	70.0
3	72.0
4	73.0
5	42.0
6	45.0
7	37.0
8	34.0
9	37.0
10	69.0
11	32.0
12	51.0
Total	56.0

Summary Statistics for ph ND

mo	Count	Average	Median
1	55	6.89818	6.9
2	13	6.88462	7.0
3	26	7.14615	7.1
4	53	7.03774	7.0
5	17	7.31176	7.4
6	51	7.11176	7.2
7	54	7.0037	7.0
8	46	7.11304	7.1
9	7	7.32857	7.2
10	38	7.10263	7.1
11	9	7.16667	7.2
12	18	7.09444	7.15
Total	387	7.06331	7.1

mo	Minimum	Maximum	Lower quartile
1	6.0	7.5	6.6
2	6.1	7.9	6.5
3	6.5	8.1	6.8
4	6.2	8.1	6.7
5	6.8	8.2	7.1
6	6.4	7.7	6.8
7	6.0	8.2	6.8
8	6.4	8.7	6.8
9	6.9	8.3	7.1
10	2.9	9.2	6.8
11	6.8	7.4	7.1
12	6.4	7.8	6.9
Total	2.9	9.2	6.8

mo	Upper quartile
1	7.2
2	7.2
3	7.3
4	7.3
5	7.4
6	7.4
7	7.2
8	7.3
9	7.3
10	7.4
11	7.3
12	7.3
Total	7.3

C-034607

Summary Statistics for so4 ND

mo	Count	Average	Median
1	57	117.842	101.0
2	12	126.083	125.5
3	15	122.0	108.0
4	49	80.6122	60.0
5	14	44.9286	25.0
6	47	41.5957	33.0
7	55	35.9091	28.0
8	38	31.3684	21.5
9	4	28.5	26.0
10	34	40.7059	22.0
11	6	32.6667	30.5
12	15	71.6	70.0
Total	346	65.1127	39.5

mo	Minimum	Maximum	Lower quartile
1	21.0	462.0	65.0
2	53.0	239.0	79.0
3	30.0	540.0	50.0
4	6.0	440.0	39.0
5	13.0	181.0	19.0
6	6.0	183.0	22.0
7	6.0	173.0	19.0
8	10.0	164.0	16.0
9	17.0	45.0	18.5
10	3.0	171.0	10.0
11	24.0	47.0	26.0
12	23.0	176.0	34.0
Total	3.0	540.0	23.0

mo	Upper quartile
1	162.0
2	146.5
3	133.0
4	103.0
5	29.0
6	48.0
7	39.0
8	32.0
9	38.5
10	48.0
11	38.0
12	96.0
Total	92.0

[redacted]

mmary Statistics for tds ND

	Count	Average	Median
[redacted]	56	553.75	543.5
[redacted]	12	572.0	543.5
[redacted]	15	593.067	594.0
[redacted]	49	467.51	406.0
5	14	332.643	226.5
[redacted]	47	298.787	252.0
[redacted]	55	247.709	202.0
[redacted]	31	275.452	205.0
9	4	234.0	236.5
10	35	405.8	344.0
[redacted]	6	344.667	318.5
[redacted]	15	397.133	392.0
Total	339	394.41	350.0

	Minimum	Maximum	Lower quartile
1	222.0	1030.0	410.0
2	351.0	984.0	418.0
[redacted]	199.0	1530.0	366.0
[redacted]	184.0	1160.0	334.0
[redacted]	136.0	830.0	178.0
6	118.0	847.0	202.0
7	85.0	779.0	167.0
[redacted]	125.0	843.0	169.0
[redacted]	160.0	303.0	198.0
[redacted]	164.0	850.0	265.0
11	264.0	527.0	287.0
12	238.0	641.0	315.0
[redacted]tal	85.0	1530.0	217.0

mo	Upper quartile
[redacted]	651.0
[redacted]	673.0
3	743.0
4	572.0
[redacted]	426.0
[redacted]	342.0
[redacted]	294.0
8	372.0
9	270.0
[redacted]	547.0
[redacted]	353.0
12	448.0
[redacted]tal	515.0

[redacted]

Summary Statistics for alk WD (West Delta)

mo	Count	Average	Median
1	21	137.095	154.0
2	5	125.4	144.0
4	27	151.148	146.0
6	14	143.571	135.5
7	28	126.179	120.5
8	19	125.211	106.0
10	19	154.526	154.0
Total	133	138.684	144.0

mo	Minimum	Maximum	Lower quartile
1	40.0	220.0	85.0
2	23.0	261.0	53.0
4	43.0	355.0	79.0
6	82.0	232.0	108.0
7	60.0	235.0	81.5
8	66.0	198.0	86.0
10	84.0	255.0	121.0
Total	23.0	355.0	88.0

mo	Upper quartile
1	183.0
2	146.0
4	191.0
6	174.0
7	165.0
8	169.0
10	183.0
Total	176.0

[redacted]

Summary Statistics for br WD

[redacted]	Count	Average	Median
[redacted]	18	0.711111	0.735
[redacted]	2	0.535	0.535
[redacted]	22	0.573636	0.555
[redacted]	10	0.556	0.565
7	28	0.55	0.59
[redacted]	19	0.606316	0.61
[redacted]	19	0.692105	0.75
Total	118	0.611186	0.6

[redacted]	Minimum	Maximum	Lower quartile
[redacted]	0.45	0.9	0.62
2	0.48	0.59	0.48
[redacted]	0.24	1.18	0.47
[redacted]	0.25	0.82	0.45
[redacted]	0.14	0.88	0.45
[redacted]	0.13	0.92	0.48
10	0.41	0.98	0.51
[redacted]otal	0.13	1.18	0.48

mo	Upper quartile
[redacted]	0.79
[redacted]	0.59
[redacted]	0.68
6	0.68
[redacted]	0.645
[redacted]	0.75
[redacted]0	0.84
Total	0.75

[redacted]

Summary Statistics for ca WD

mo	Count	Average	Median
1	21	85.1429	88.0
2	5	134.6	87.0
4	27	67.6667	64.0
6	14	48.2143	47.5
7	28	43.5714	39.0
8	19	40.1579	40.0
10	19	53.0	45.0
Total	133	59.797	51.0

mo	Minimum	Maximum	Lower quartile
1	58.0	152.0	67.0
2	71.0	256.0	82.0
4	41.0	129.0	52.0
6	24.0	81.0	36.0
7	23.0	99.0	35.5
8	21.0	52.0	37.0
10	26.0	103.0	40.0
Total	21.0	256.0	40.0

mo	Upper quartile
1	97.0
2	177.0
4	83.0
6	62.0
7	50.5
8	46.0
10	59.0
Total	74.0

Summary Statistics for cl WD

mo	Count	Average	Median
1	21	279.667	284.0
[redacted]	5	279.4	281.0
[redacted]	27	215.556	191.0
[redacted]	14	170.0	174.0
7	28	161.214	167.5
[redacted]	19	166.895	171.0
[redacted]0	19	178.368	177.0
Total	133	199.579	188.0

mo	Minimum	Maximum	Lower quartile
[redacted]	175.0	378.0	227.0
2	236.0	312.0	267.0
4	132.0	542.0	164.0
[redacted]	82.0	261.0	134.0
[redacted]	44.0	242.0	131.0
[redacted]	50.0	256.0	139.0
10	97.0	287.0	124.0
Total	44.0	542.0	152.0

mo	Upper quartile
[redacted]	317.0
[redacted]	301.0
[redacted]	253.0
6	211.0
7	193.5
[redacted]	197.0
[redacted]0	229.0
Total	238.0

Summary Statistics for ec WD

mo	Count	Average	Median
1	21	1609.1	1680.0
2	5	1940.0	2000.0
4	27	1303.63	1140.0
6	14	997.143	938.0
7	28	899.25	879.0
8	19	888.579	848.0
10	19	1039.58	922.0
Total	133	1161.38	1050.0

mo	Minimum	Maximum	Lower quartile
1	991.0	2190.0	1360.0
2	1370.0	2530.0	1560.0
4	865.0	2870.0	1050.0
6	592.0	1580.0	845.0
7	415.0	1440.0	802.5
8	427.0	1260.0	769.0
10	568.0	1670.0	757.0
Total	415.0	2870.0	857.0

mo	Upper quartile
1	1860.0
2	2240.0
4	1380.0
6	1190.0
7	984.0
8	1030.0
10	1370.0
Total	1370.0

mmary Statistics for mg WD

	Count	Average	Median
	21	53.4762	53.0
	5	76.6	68.0
	27	44.2222	42.0
6	14	30.8571	25.0
7	28	27.0	26.0
	19	26.1579	25.0
	19	33.2632	29.0
Total	133	37.7218	31.0

	Minimum	Maximum	Lower quartile
	24.0	86.0	43.0
2	46.0	126.0	51.0
	24.0	114.0	29.0
	16.0	61.0	23.0
	12.0	49.0	22.0
8	14.0	37.0	22.0
10	15.0	79.0	22.0
tal	12.0	126.0	25.0

mo	Upper quartile
	66.0
	92.0
	50.0
6	36.0
	29.5
	30.0
	40.0
Total	47.0

Summary Statistics for na WD

mo	Count	Average	Median
1	21	168.476	168.0
2	5	176.6	179.0
4	27	139.222	115.0
6	14	110.286	104.5
7	28	99.9286	96.5
8	19	99.7368	92.0
10	19	110.316	98.0
Total	133	124.158	115.0

mo	Minimum	Maximum	Lower quartile
1	98.0	253.0	125.0
2	127.0	246.0	151.0
4	80.0	335.0	103.0
6	71.0	182.0	86.0
7	42.0	165.0	82.5
8	41.0	155.0	82.0
10	62.0	177.0	78.0
Total	41.0	335.0	93.0

mo	Upper quartile
1	202.0
2	180.0
4	161.0
6	124.0
7	118.0
8	126.0
10	138.0
Total	144.0

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Summary Statistics for ph WD

mo	Count	Average	Median
1	21	6.97143	7.0
2	5	6.42	6.6
[redacted]	27	7.20741	7.2
[redacted]	14	7.13571	7.15
7	25	7.072	7.1
8	15	7.13333	7.2
10	19	7.29474	7.2
Total	126	7.10635	7.1

mo	Minimum	Maximum	Lower quartile
[redacted]	6.2	7.5	6.7
2	5.8	6.8	6.2
4	6.2	9.2	6.6
[redacted]	6.8	7.4	7.0
[redacted]	6.7	7.7	6.9
[redacted]	6.5	7.6	7.0
10	6.5	8.0	7.0
Total	5.8	9.2	6.9

mo	Upper quartile
1	7.2
[redacted]	6.7
[redacted]	7.5
6	7.3
7	7.2
[redacted]	7.4
10	7.7
Total	7.3

ummary Statistics for so4 WD

o	Count	Average	Median
	21	244.714	245.0
	5	465.4	315.0
	27	176.704	152.0
	14	94.4286	75.0
	28	77.6429	68.0
	19	61.3158	61.0
0	19	85.2105	44.0
otal	133	139.226	93.0

o	Minimum	Maximum	Lower quartile
	56.0	554.0	182.0
	190.0	900.0	226.0	
	49.0	353.0	94.0
	13.0	271.0	35.0
	5.0	302.0	43.0
	12.0	138.0	45.0
0	6.0	334.0	25.0
otal	5.0	900.0	50.0

o	Upper quartile
	321.0
	696.0
	250.0
	146.0
	95.0
	80.0
0	115.0
otal	216.0

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Summary Statistics for tds WD

mo	Count	Average	Median
1	21	1019.76	1070.0
[redacted]	5	1355.4	1270.0
[redacted]	27	830.074	719.0
[redacted]	14	599.643	542.5
7	28	540.893	531.0
[redacted]	19	527.474	502.0
[redacted]0	19	624.895	542.0
Total	133	722.098	633.0

mo	Minimum	Maximum	Lower quartile
[redacted]	562.0	1400.0	847.0
2	873.0	1970.0	974.0
4	533.0	1810.0	642.0
[redacted]	349.0	1020.0	493.0
[redacted]	253.0	984.0	479.0
[redacted]	249.0	719.0	474.0
10	323.0	1090.0	473.0
Total	249.0	1970.0	507.0

mo	Upper quartile
[redacted]	1160.0
[redacted]	1690.0
[redacted]	908.0
6	725.0
7	573.5
[redacted]	628.0
[redacted]0	776.0
Total	878.0

Summary Statistics for alk [redacted] SED (South East Delta)

mo	Count	Average	Median
1	87	148.667	136.0
2	21	169.381	156.0
3	14	169.286	171.5
4	78	155.179	164.0
5	17	155.059	156.0
6	64	123.188	108.0
7	80	124.738	105.5
8	62	122.613	98.0
9	4	229.0	227.0
10	64	158.453	162.0
11	5	111.2	105.0
12	16	121.438	92.5
Total	512	141.84	136.5

mo	Minimum	Maximum	Lower quartile
1	47.0	357.0	97.0
2	93.0	294.0	136.0
3	87.0	234.0	162.0
4	48.0	352.0	102.0
5	68.0	252.0	123.0
6	54.0	294.0	74.0
7	41.0	247.0	73.0
8	56.0	320.0	76.0
9	187.0	275.0	192.5
10	65.0	326.0	95.5
11	82.0	142.0	100.0
12	62.0	290.0	74.5
Total	41.0	357.0	86.5

mo	Upper quartile
1	191.0
2	183.0
3	180.0
4	192.0
5	193.0
6	170.5
7	173.5
8	171.0
9	265.5
10	200.0
11	127.0
12	143.5
Total	184.0

[redacted]

[redacted]mmary Statistics for br SED

mo	Count	Average	Median
[redacted]	41	0.608293	0.42
[redacted]	1	0.41	0.41
[redacted]	1	2.7	2.7
4	40	0.55275	0.325
5	2	0.415	0.415
[redacted]	34	0.467647	0.32
[redacted]	59	0.447627	0.35
[redacted]	49	0.491837	0.38
10	48	0.711458	0.53
[redacted]tal	275	0.551091	0.38

mo	Minimum	Maximum	Lower quartile
[redacted]	0.07	1.8	0.32
[redacted]	0.41	0.41	0.41
[redacted]	2.7	2.7	2.7
4	0.08	2.04	0.21
5	0.41	0.42	0.41
[redacted]	0.02	1.53	0.18
[redacted]	0.07	1.28	0.21
[redacted]	0.09	1.64	0.26
10	0.08	2.5	0.24
[redacted]tal	0.02	2.7	0.24

mo	Upper quartile
[redacted]	0.76
[redacted]	0.41
[redacted]	2.7
4	0.735
5	0.42
[redacted]	0.66
[redacted]	0.68
[redacted]	0.65
10	1.1
[redacted]tal	0.75

[redacted]

Summary Statistics for ca (SF Delta)

mo	Count	Average	Median
1	81	82.2222	64.0
2	21	84.5667	82.0
3	14	89.8571	63.5
4	76	67.2308	48.0
5	17	57.5882	54.0
6	64	51.6406	41.0
7	80	49.1	38.5
8	62	46.0323	37.0
9	4	144.0	127.5
10	64	66.9063	47.0
11	5	59.4	64.0
12	16	53.625	51.0
Total	506	63.2707	50.5

mo	Minimum	Maximum	Lower quartile
1	25.0	170.0	50.0
2	42.0	150.0	51.0
3	36.0	205.0	52.0
4	16.0	196.0	39.0
5	24.0	108.0	46.0
6	14.0	150.0	32.5
7	16.0	117.0	27.5
8	15.0	123.0	25.0
9	114.0	207.0	117.0
10	20.0	154.0	33.0
11	22.0	105.0	36.0
12	35.0	90.0	44.5
Total	14.0	207.0	36.0

mo	Upper quartile
1	101.0
2	110.0
3	140.0
4	86.0
5	69.0
6	70.0
7	64.0
8	62.0
9	171.0
10	106.0
11	70.0
12	60.0
Total	85.0

Summary Statistics for cl SED

mo	Count	Average	Median
[redacted]	88	221.25	158.0
[redacted]	25	268.04	226.0
[redacted]	24	243.875	192.0
[redacted]	82	206.756	133.5
5	18	161.056	129.0
[redacted]	65	150.8	104.0
[redacted]	81	133.346	110.0
[redacted]	68	126.912	93.0
9	5	492.8	548.0
10	65	214.062	128.0
[redacted]1	6	219.667	180.5
[redacted]2	17	126.176	125.0
Total	544	185.572	132.0

mo	Minimum	Maximum	Lower quartile
1	14.0	614.0	108.5
2	19.0	685.0	141.0
[redacted]	20.0	655.0	75.5
[redacted]	15.0	695.0	72.0
[redacted]	19.0	566.0	73.0
6	9.0	830.0	64.0
[redacted]7	14.0	365.0	60.0
[redacted]	16.0	406.0	58.5
[redacted]	172.0	700.0	492.0
10	13.0	680.0	80.0
11	14.0	452.0	112.0
[redacted]2	45.0	277.0	71.0
[redacted]otal	9.0	830.0	70.0

mo	Upper quartile
[redacted]1	312.5
[redacted]2	396.0
3	386.0
[redacted]4	307.0
[redacted]5	194.0
[redacted]6	217.0
[redacted]7	206.0
8	169.0
[redacted]9	552.0
[redacted]10	376.0
[redacted]11	379.0
12	170.0
[redacted]Total	258.5

Summary Statistics for ec SED

no	Count	Average	Median
1	88	1261.58	1035.0
2	25	1411.56	1340.0
3	24	1289.92	1130.0
4	82	1144.26	785.5
5	18	955.5	855.0
6	65	878.477	673.0
7	81	826.012	667.0
8	68	779.882	594.0
9	5	2083.2	2140.0
10	65	1152.17	810.0
11	6	1111.33	1079.0
12	17	835.471	739.0
Total	544	1050.57	805.5

no	Minimum	Maximum	Lower quartile
1	352.0	3070.0	800.0
2	456.0	2610.0	1010.0
3	420.0	2840.0	744.0
4	236.0	3420.0	631.0
5	377.0	2280.0	647.0
6	160.0	2760.0	497.0
7	281.0	2000.0	477.0
8	272.0	2070.0	473.0
9	886.0	2960.0	2120.0
10	363.0	3160.0	546.0
11	312.0	1880.0	718.0
12	585.0	1340.0	652.0
Total	160.0	3420.0	538.5

no	Upper quartile
1	1515.0
2	1880.0
3	1895.0
4	1650.0
5	1120.0
6	1070.0
7	1040.0
8	938.0
9	2310.0
10	1720.0
11	1600.0
12	992.0
Total	1445.0

Summary Statistics for mg SED

mo	Count	Average	Median
[redacted]	81	44.5432	35.0
[redacted]	21	44.2381	45.0
[redacted]	14	44.7857	33.0
4	78	34.8974	24.0
5	17	28.9412	28.0
[redacted]	64	26.7344	19.5
[redacted]	80	25.6125	18.0
[redacted]	62	25.0323	17.5
9	4	75.75	71.5
10	64	36.5938	24.0
[redacted]1	5	34.0	31.0
[redacted]2	16	29.4375	26.0
Total	506	33.5494	25.0

[redacted]o	Minimum	Maximum	Lower quartile
1	15.0	102.0	26.0
2	17.0	77.0	25.0
[redacted]	18.0	100.0	22.0
[redacted]	9.0	110.0	18.0
[redacted]	12.0	56.0	21.0
6	5.0	84.0	15.0
[redacted]7	10.0	63.0	14.0
[redacted]	9.0	66.0	14.0
[redacted]	64.0	96.0	66.0
10	12.0	110.0	16.0
11	16.0	51.0	21.0
[redacted]2	20.0	51.0	23.0
[redacted]otal	5.0	110.0	17.0

mo	Upper quartile
[redacted]	55.0
2	63.0
3	66.0
[redacted]	47.0
[redacted]	34.0
[redacted]	36.0
7	35.5
8	34.0
[redacted]	85.5
[redacted]0	58.5
[redacted]1	51.0
12	32.0
[redacted]otal	46.0

Summary Statistics for na SED

mo	Count	Average	Median
1	87	114.31	95.0
2	25	124.92	120.0
3	24	118.083	114.0
4	82	110.024	79.5
5	18	91.1111	78.0
6	65	87.5538	68.0
7	81	84.0741	60.0
8	68	78.3382	59.5
9	5	186.6	192.0
10	65	112.308	79.0
11	6	99.1667	97.0
12	17	74.2353	78.0
Total	543	100.335	78.0

mo	Minimum	Maximum	Lower quartile
1	19.0	372.0	74.0
2	27.0	252.0	93.0
3	26.0	236.0	56.5
4	18.0	389.0	54.0
5	22.0	248.0	50.0
6	8.0	296.0	42.0
7	19.0	232.0	45.0
8	18.0	231.0	45.0
9	83.0	274.0	153.0
10	19.0	317.0	50.0
11	21.0	170.0	64.0
12	40.0	115.0	49.0
Total	8.0	389.0	50.0

mo	Upper quartile
1	132.0
2	160.0
3	177.5
4	149.0
5	131.0
6	108.0
7	121.0
8	85.0
9	231.0
10	168.0
11	146.0
12	87.0
Total	141.0

Summary Statistics for ph SED

mo	Count	Average	Median
[redacted]	86	7.03721	7.05
[redacted]	25	7.408	7.2
[redacted]	24	7.17083	7.1
4	82	7.35244	7.3
5	18	7.50556	7.5
[redacted]	65	7.20615	7.1
[redacted]	72	7.11806	7.1
[redacted]	62	7.00484	7.0
9	5	7.18	7.2
10	64	7.35938	7.1
[redacted]	6	7.03333	7.15
[redacted]	17	6.88235	7.0
Total	526	7.18973	7.1

mo	Minimum	Maximum	Lower quartile
1	6.0	9.9	6.7
2	6.5	8.9	6.8
[redacted]	6.0	8.1	7.0
[redacted]	6.4	14.6	7.1
5	6.6	8.4	7.3
6	6.6	8.2	6.9
[redacted]	5.7	8.2	6.8
[redacted]	6.2	8.6	6.7
[redacted]	6.9	7.3	7.2
10	5.9	10.2	6.75
11	6.3	7.5	6.8
[redacted]	6.2	7.4	6.5
Total	5.7	14.6	6.8

mo	Upper quartile
[redacted]	7.3
2	7.8
3	7.3
[redacted]	7.5
5	7.6
6	7.5
7	7.5
8	7.3
[redacted]	7.3
10	7.5
11	7.3
12	7.1
[redacted]	7.4

C-034627

Summary Statistics for so4 SED

mo	Count	Average	Median
1	87	154.621	137.0
2	21	128.619	127.0
3	14	99.9286	83.0
4	78	100.333	69.0
5	17	72.0588	65.0
6	64	85.9219	63.5
7	80	87.325	56.0
8	62	70.6935	47.0
9	4	115.75	119.0
10	64	93.6406	42.0
11	5	103.0	75.0
12	16	96.75	87.0
Total	512	101.543	67.0

mo	Minimum	Maximum	Lower quartile
1	5.0	482.0	61.0
2	14.0	382.0	44.0
3	12.0	345.0	33.0
4	3.0	544.0	33.0
5	6.0	200.0	22.0
6	4.0	302.0	31.5
7	2.0	287.0	31.0
8	2.0	265.0	23.0
9	25.0	200.0	35.5
10	2.0	426.0	25.0
11	20.0	186.0	60.0
12	36.0	171.0	68.0
Total	2.0	544.0	33.0

mo	Upper quartile
1	226.0
2	178.0
3	119.0
4	118.0
5	114.0
6	107.0
7	145.5
8	89.0
9	196.0
10	132.5
11	174.0
12	132.0
Total	152.0

[redacted]

[redacted]mmary Statistics for tds SED

mo	Count	Average	Median
[redacted]	87	798.414	672.0
	21	816.571	752.0
	14	884.143	653.5
4	77	665.286	482.0
5	17	561.588	590.0
	64	537.5	418.0
	80	515.438	415.0
[redacted]	55	472.655	369.0
9	4	1410.0	1415.0
10	64	702.344	498.5
[redacted]	5	630.4	664.0
	16	537.188	494.0
Total	504	642.321	500.5

[redacted]	Minimum	Maximum	Lower quartile
1	230.0	1920.0	518.0
2	299.0	1430.0	594.0
[redacted]	290.0	1860.0	457.0
	146.0	2230.0	386.0
[redacted]	231.0	1190.0	388.0
6	95.0	1630.0	295.0
[redacted]	184.0	1250.0	288.0
	168.0	1240.0	270.0
	1320.0	1490.0	1330.0
10	241.0	2120.0	342.5
11	205.0	932.0	436.0
[redacted]	378.0	875.0	428.0
[redacted]otal	95.0	2230.0	341.0

mo	Upper quartile
[redacted]	1060.0
2	987.0
3	1410.0
[redacted]	681.0
	672.0
	665.5
7	637.5
8	601.0
[redacted]	1490.0
[redacted]0	1030.0
11	915.0
12	643.0
[redacted]otal	879.0

[redacted]

Regression Analysis - Linear model: Y = a + b*X

Dependent variable: UVA
Independent variable: DOC

Parameter	Estimate	Standard Error	T Statistic	P-Value
Intercept	0.0519135	0.0101533	5.11295	0.0000
Slope	0.0165655	0.00125946	13.1529	0.0000

Analysis of Variance

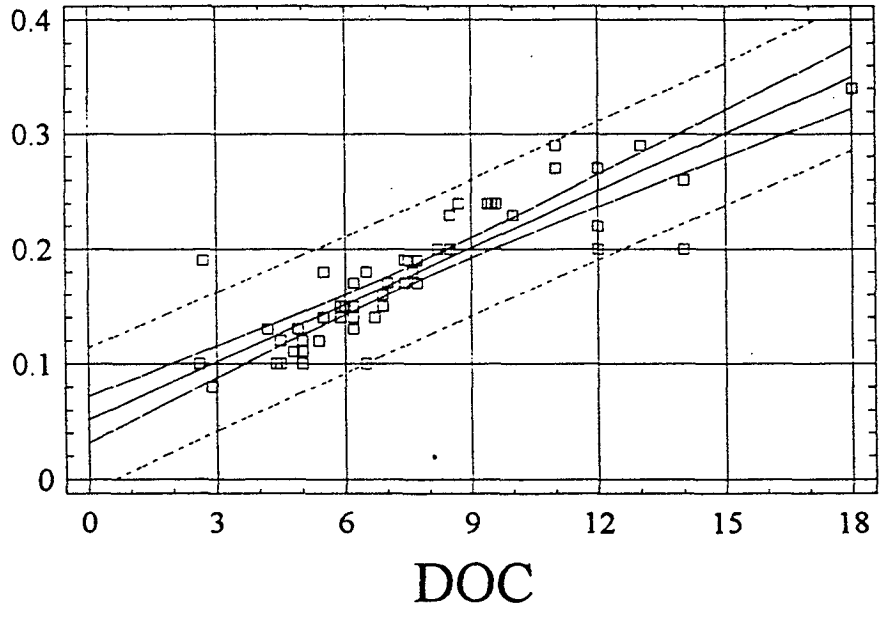
Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	0.147849	1	0.147849	173.00	0.0000
Residual	0.0461496	54	0.000854622		
Total (Corr.)	0.193998	55			

Correlation Coefficient = 0.872991
R-squared = 76.2113 percent
Standard Error of Est. = 0.0292339

Low DOC region

C-034630

Plot of Fitted Model



Low DOC region

Regression Analysis - Linear model: Y = a + b*X

Dependent variable: UVA
Independent variable: DOC

Parameter	Estimate	Standard Error	T Statistic	P-Value
Intercept	-0.012649	0.0339385	-0.372704	0.7106
Slope	0.0482997	0.0018303	26.389	0.0000

Analysis of Variance

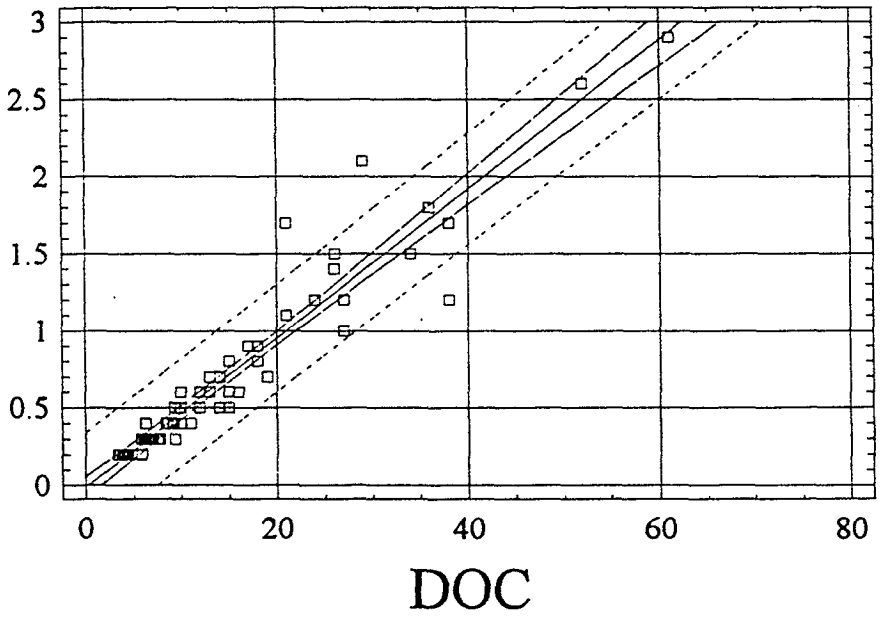
Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Model	20.8579	1	20.8579	696.38	0.0000
Residual	1.97683	66	0.0299519		
Total (Corr.)	22.8347	67			

Correlation Coefficient = 0.955735
R-squared = 91.3429 percent
Standard Error of Est. = 0.173066

Mid-range DOC region

C-034632

Plot of Fitted Model



Mid-range DOC region

C-034633

egression Analysis - Linear model: Y = a + b*X

ependent variable: uva
ndependent variable: doc

arameter	Estimate	Standard Error	T Statistic	P-Value
ntercept	0.101449	0.0217577	4.66267	0.0000
lope	0.0410927	0.000833422	49.306	0.0000

Analysis of Variance

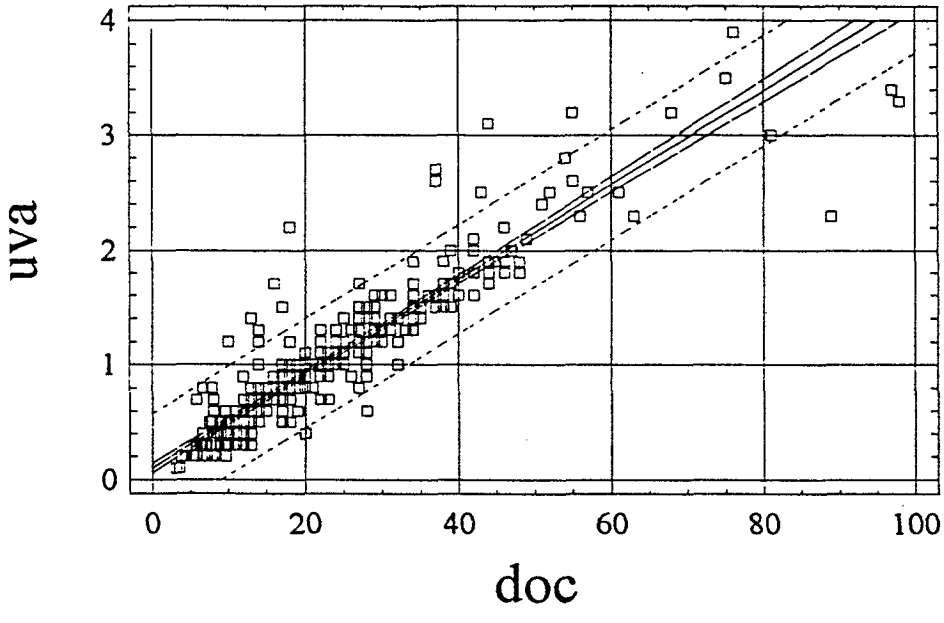
ource	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
odel	141.588	1	141.588	2431.08	0.0000
esidual	22.8304	392	0.0582409		
otal (Corr.)	164.419	393			

orrelation Coefficient = 0.927979
-squared = 86.1145 percent
tandard Error of Est. = 0.241331

High DOC region

C-034634

Plot of Fitted Model



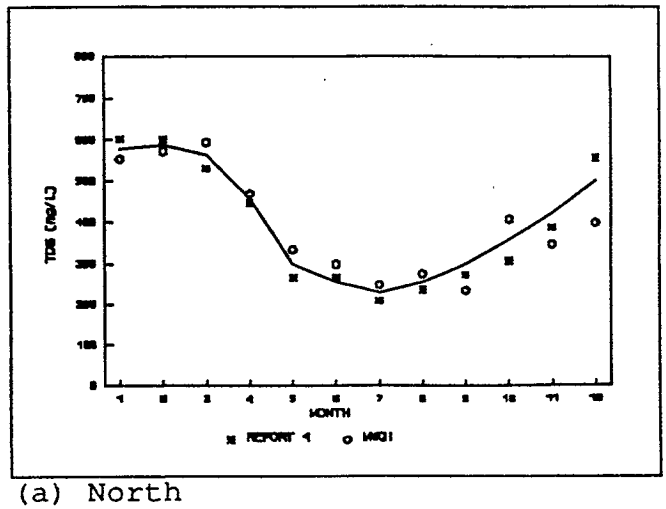
High DOC region

C-034635

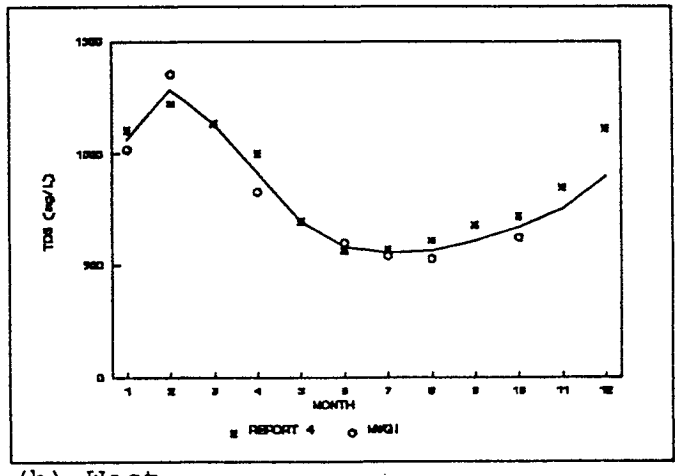
APPENDIX B

MONTHLY MINERAL AND EC PLOTS

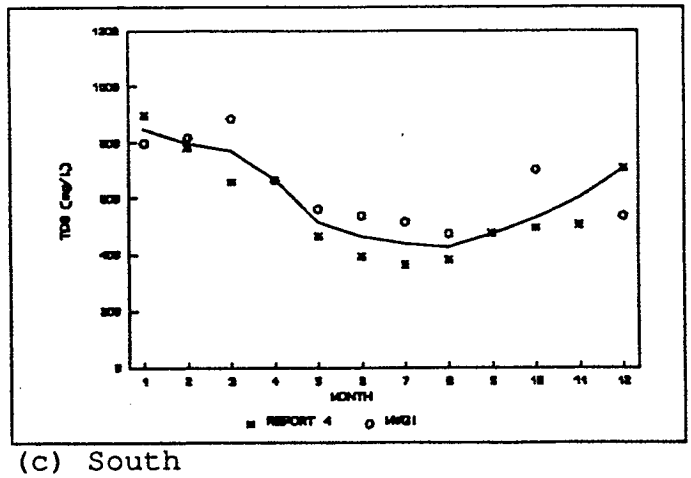
Figure B-1
TDS in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North



(b) West



(c) South

Figure B-2
Alkalinity in North Delta Return Flows: Smoothed and Unsmoothed Values

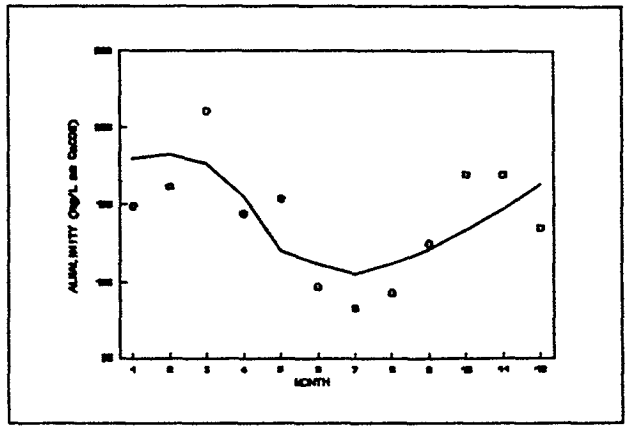
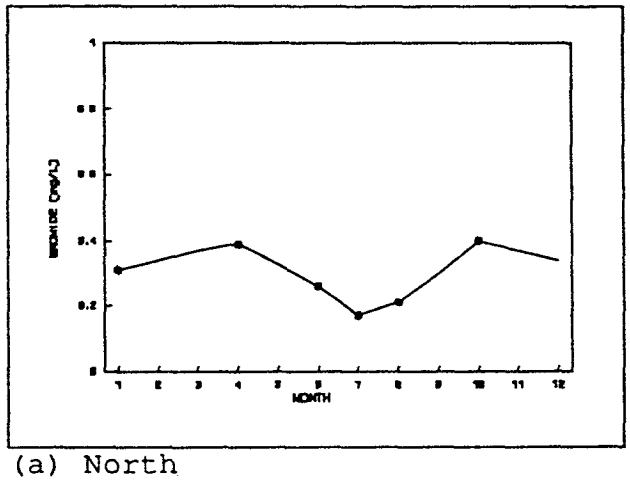
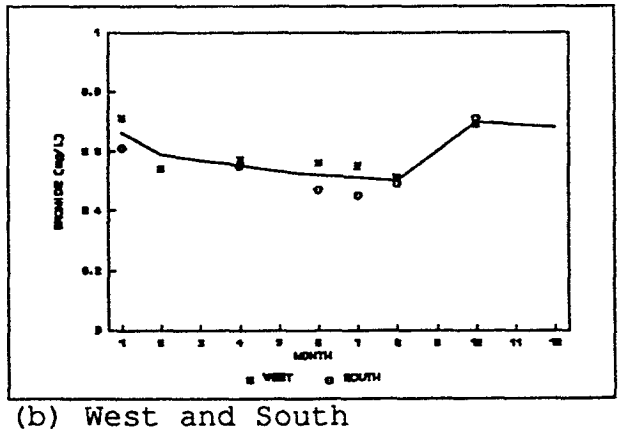


Figure B-3
Bromide in Delta Return Flows: Smoothed and Unsmoothed Values



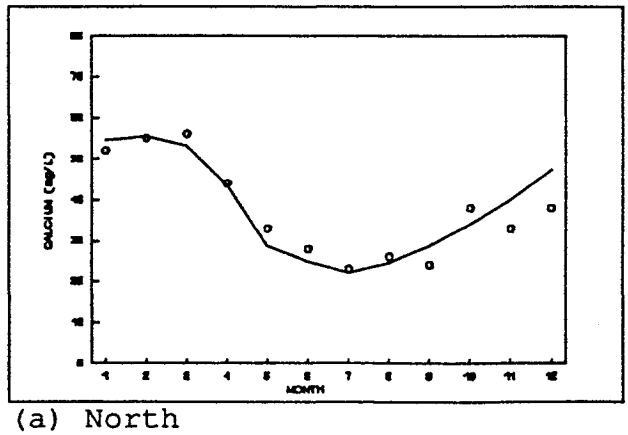
(a) North



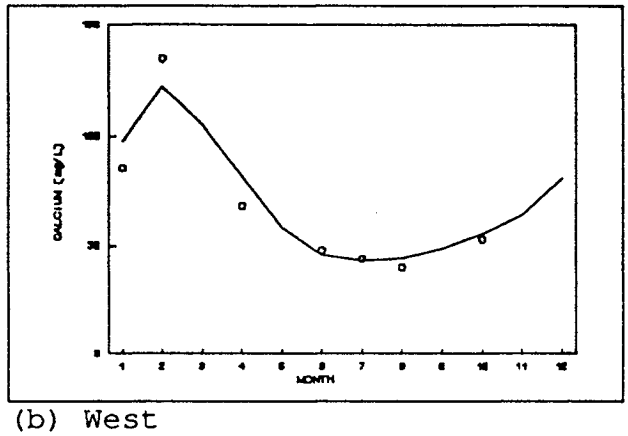
(b) West and South

C-034638

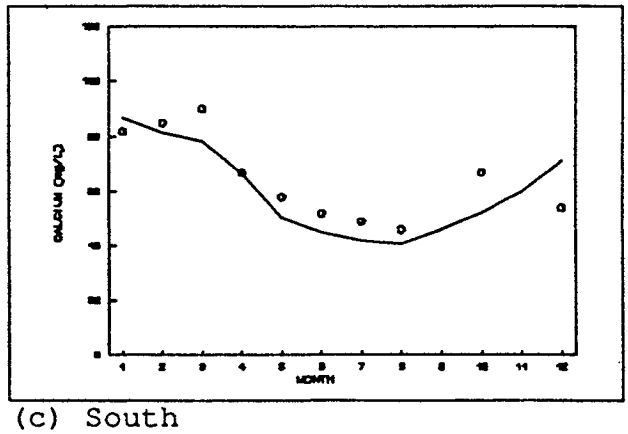
Figure B-4
Calcium in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North

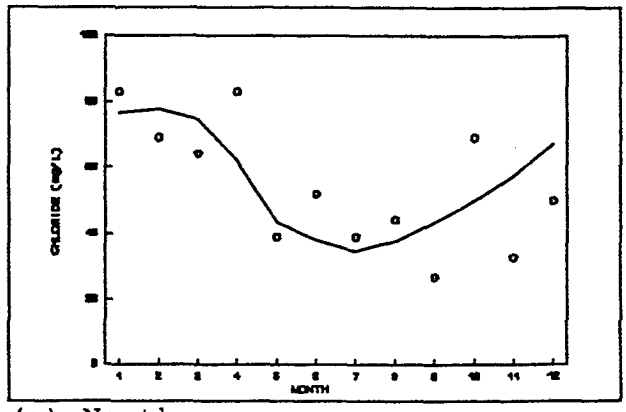


(b) West

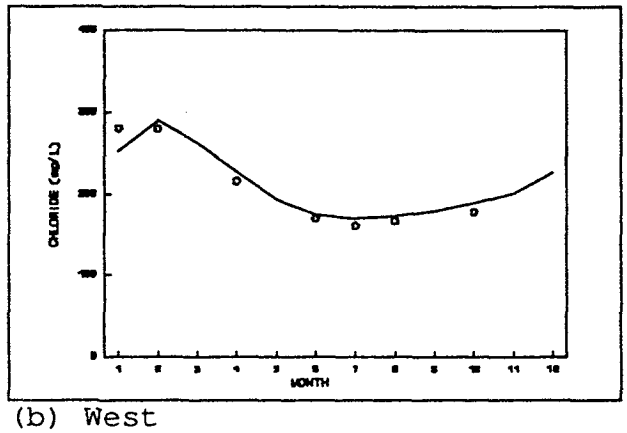


(c) South

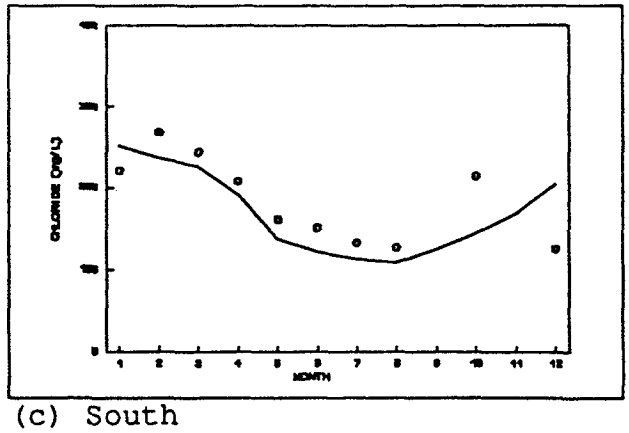
Figure B-5
Chloride in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North



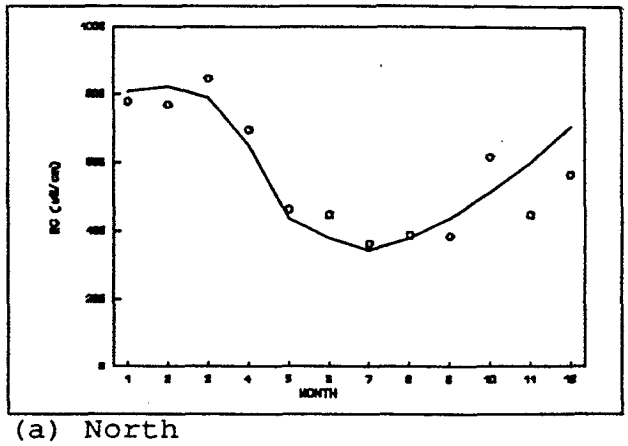
(b) West



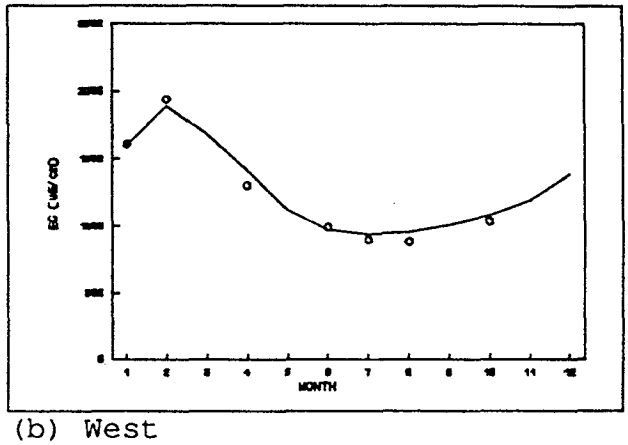
(c) South

C-034640

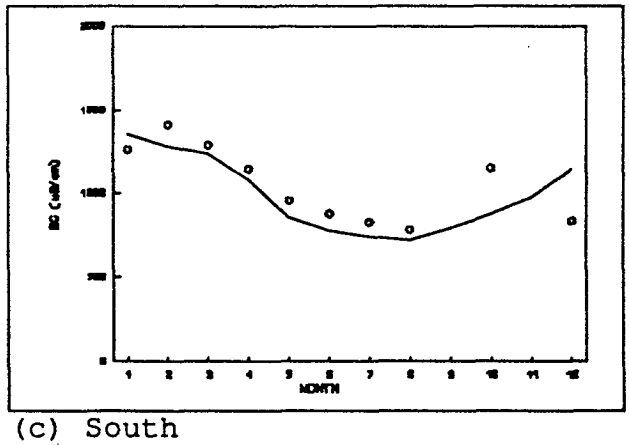
Figure B-6
Electrical Conductivity in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North

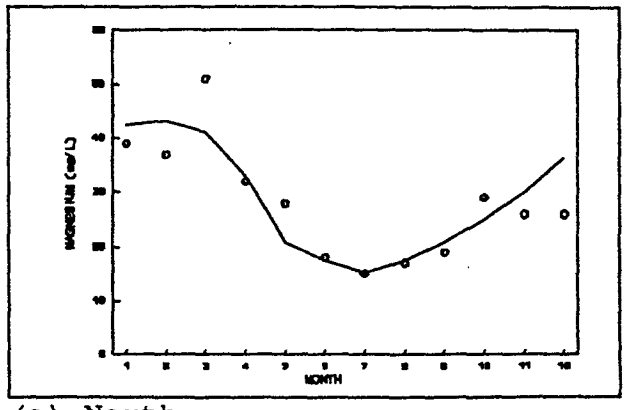


(b) West

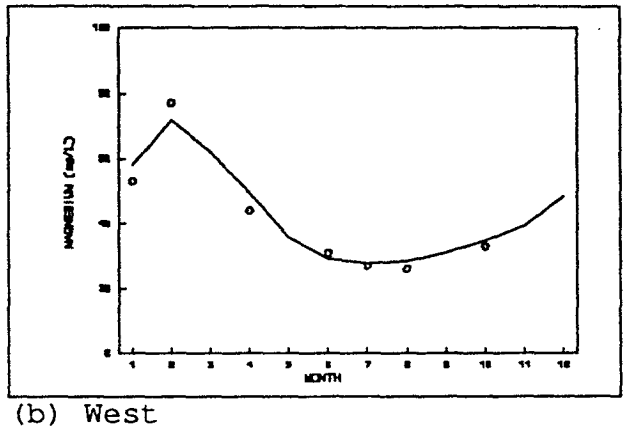


(c) South

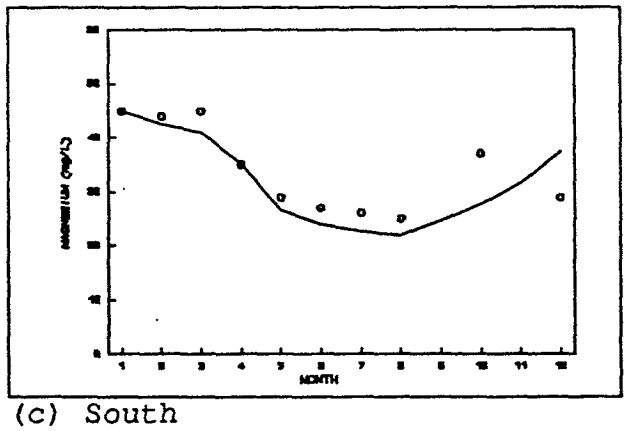
Figure B-7
Magnesium in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North

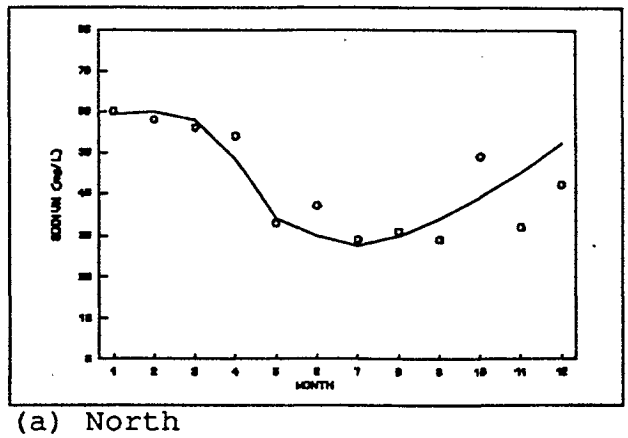


(b) West

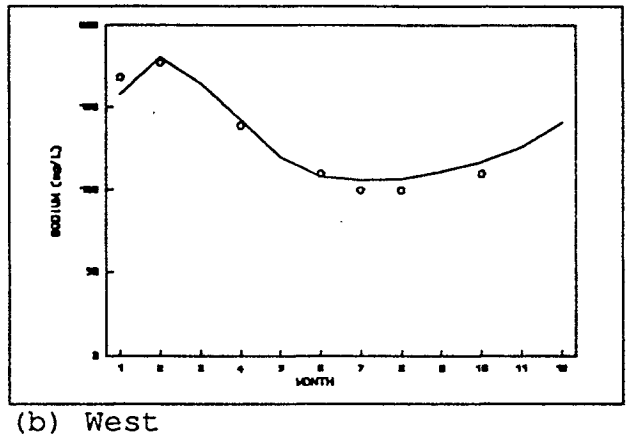


(c) South

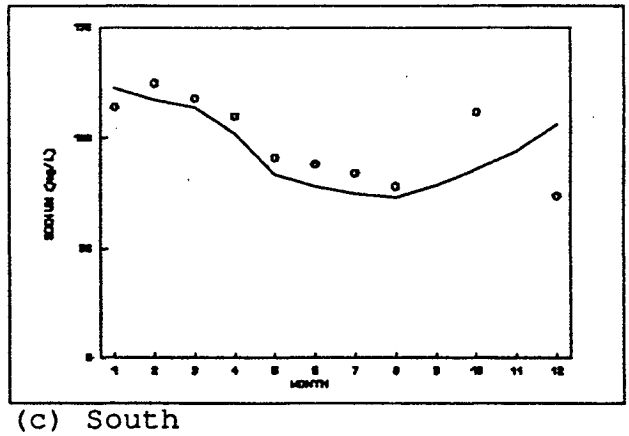
Figure B-8
Sodium in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North

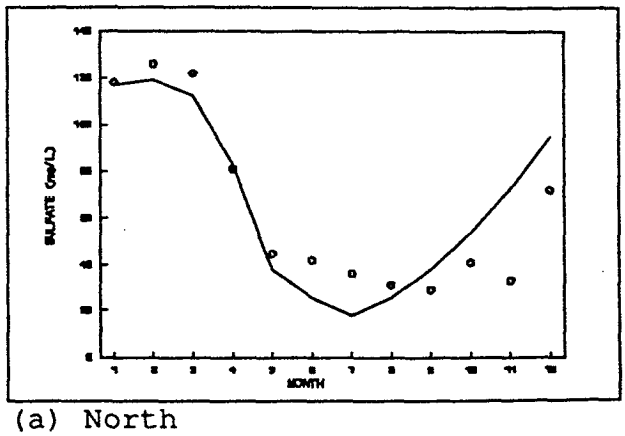


(b) West

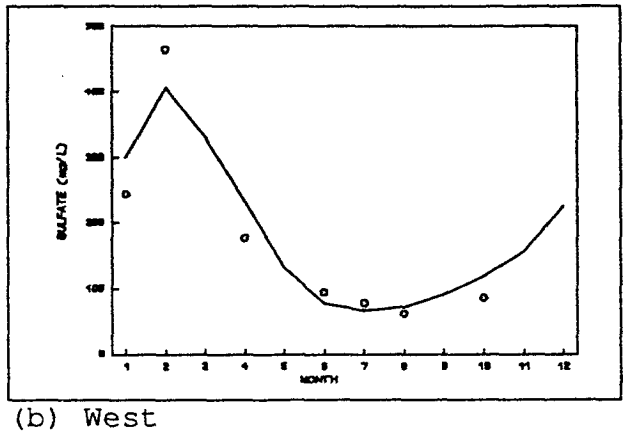


(c) South

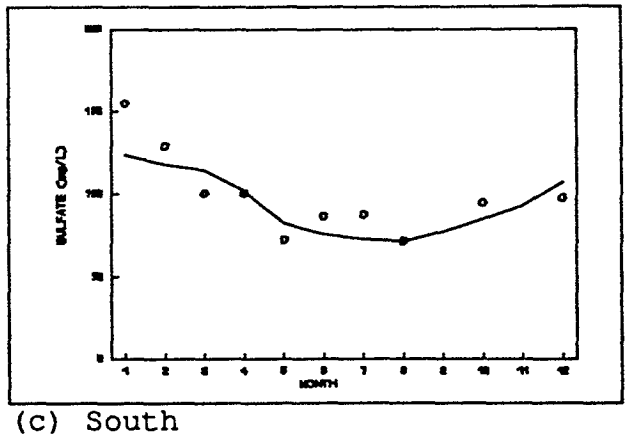
Figure B-9
Sulfate in Delta Return Flows: Smoothed and Unsmoothed Values



(a) North



(b) West



(c) South

C-034644

APPENDIX C

NODE ASSIGNMENT TO DELTA SUBREGIONS

DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION	DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION
1	South	Low	36	South	High
2	South	Low	37	South	High
3	South	Low	38	South	High
4	South	Low	39	South	High
5	South	Low	40	South	High
6	South	Low	41	West	High
7	South	Low	42	West	High
8	South	Low	43	West	High
9	South	Low	44	West	High
10	South	Mid	45	West	High
11	South	Low	46	West	High
12	South	Mid	47	West	High
13	South	Mid	48	South	Mid
14	South	Mid	49	South	Mid
15	South	Mid	50	South	Mid
16	South	Mid	51	South	Mid
17	South	Mid	52	South	Mid
18	South	Low	53	South	Low
19	South	Low	54	South	Low
20	South	Low	55	South	Low
21	South	High	56	South	Low
22	South	High	57	South	Low
23	South	Mid	58	South	Low
24	South	High	59	South	Low
25	South	High	60	South	Low
26	South	High	61	South	Low
27	South	High	62	South	Low
28	South	Mid	63	South	Low
29	South	High	64	South	Low
30	South	Mid	65	South	Low
31	South	Mid	66	South	Low
32	South	Mid	67	South	Low
33	South	High	68	South	Low
34	South	High	69	South	Low
35	South	Mid	70	South	High

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DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION	DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION
71	South	High	107	South	Mid
72	South	High	108	South	Mid
73	South	High	109	South	Mid
74	South	High	110	South	Mid
75	South	High	111	South	Mid
77	South	High	112	South	Low
78	South	Mid	113	South	Mid
79	South	Mid	114	South	Mid
80	South	Mid	115	South	Mid
81	South	High	116	South	Mid
82	South	High	117	South	Mid
83	South	High	118	South	Mid
84	South	High	119	South	Mid
85	South	High	120	South	Mid
86	South	High	121	South	Mid
87	South	High	122	South	Mid
88	South	High	123	South	Mid
89	South	High	124	South	Mid
90	South	High	125	South	Mid
91	South	High	126	South	Mid
92	South	High	127	South	Mid
93	South	High	128	South	Mid
94	South	High	129	South	Mid
95	South	High	130	South	Mid
96	South	High	131	South	Mid
97	South	High	132	South	Mid
98	South	High	133	South	Mid
99	South	High	134	South	Mid
100	South	Mid	135	South	Mid
101	South	High	136	South	Mid
102	South	High	137	South	Mid
103	South	High	138	South	Mid
104	South	Low	139	South	Mid
105	South	Low	140	South	Mid
106	South	Low	141	South	Mid

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DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION	DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION
142	South	Mid	178	South	Low
143	South	Mid	179	South	Low
144	South	Mid	181	South	Low
145	South	Mid	182	South	Low
146	South	Mid	183	South	Low
147	South	Mid	184	South	Low
148	South	Mid	185	South	Low
149	South	Low	186	South	Low
150	South	Low	187	South	Low
151	South	Low	188	South	Mid
152	South	Low	189	South	Low
153	South	Low	190	South	Low
154	South	Low	191	South	Low
155	South	Low	192	South	Low
156	South	Low	193	West	High
157	South	Low	194	South	Mid
158	South	Low	195	South	Mid
159	South	Low	196	West	High
160	South	Low	197	West	High
162	South	Low	198	West	High
163	South	Low	199	West	High
164	South	Low	200	West	High
165	South	Low	201	West	High
166	South	Low	202	West	High
167	South	Low	203	West	High
168	South	Low	204	West	High
169	South	Low	205	West	High
170	South	Low	206	West	High
171	South	Low	207	South	Mid
172	South	Low	208	South	Mid
173	South	Low	209	West	High
174	South	Low	210	West	High
175	South	Low	211	West	High
176	South	Low	212	West	High
177	South	Low	213	South	Mid

C-034648

DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION	DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION
215	West	High	258	North	Mid
216	West	High	259	North	Mid
217	West	High	260	North	Mid
218	West	High	261	North	Mid
219	West	High	262	North	Mid
220	West	High	263	North	High
221	West	High	264	North	Mid
222	West	High	265	North	High
223	West	High	266	North	High
224	West	High	267	North	High
225	West	High	268	North	High
226	West	High	269	North	High
227	West	Low	270	North	High
228	West	Low	271	North	Mid
232	South	High	272	North	High
238	West	Low	273	North	High
239	North	High	274	North	Mid
240	North	High	275	North	Mid
241	South	High	276	North	Mid
242	South	High	277	North	Mid
243	South	High	278	North	Mid
244	South	High	279	North	Mid
245	North	High	280	North	Mid
246	South	High	281	North	High
247	South	High	282	North	Mid
248	South	High	283	North	High
249	South	High	284	North	High
250	North	High	285	North	High
251	North	High	286	North	Mid
252	West	High	287	North	High
253	North	Mid	288	North	Mid
254	North	Mid	289	North	Mid
255	North	Mid	290	North	Mid
256	North	Mid	291	North	Mid
257	North	Mid	292	North	Mid

DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION	DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION
293	North	Mid	328	West	Low
294	North	Mid	329	West	Low
295	North	Mid	330	North	Low
296	North	Low	331	North	Low
297	North	Low	332	North	Low
298	North	Low	333	North	Low
299	North	Low	334	North	Low
300	North	Low	335	North	Low
301	North	Low	336	North	Mid
302	North	Low	337	North	Mid
303	North	Mid	338	North	Mid
304	North	Mid	339	North	Mid
305	North	Mid	340	North	Mid
306	North	Mid	341	North	Mid
307	North	Low	342	North	Mid
308	North	Mid	343	North	Mid
309	North	Low	344	North	Mid
310	North	Low	345	North	Mid
311	North	Low	346	North	Mid
312	North	Low	347	North	Mid
313	North	Low	348	North	Mid
314	North	Mid	349	North	Mid
315	North	Mid	350	North	Mid
316	North	High	351	North	High
317	North	Mid	352	North	High
318	North	Mid	353	West	High
319	North	Mid	354	West	High
320	North	Mid	355	West	High
321	North	Mid	356	West	Low
322	North	High	357	West	Low
323	North	High	358	West	Low
324	North	High	359	West	Low
325	North	High	360	West	Low
326	North	High	361	West	Low
327	West	Low	362	West	Low

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DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION	DWRDSM NODE	BULLETIN 123 SUBREGION	DOC SUBREGION
363	West	Low	401	West	Low
364	West	Low	402	West	Low
365	West	Low	403	West	Low
366	West	Low	406	West	Low
367	West	Low	408	West	Low
368	West	Low	409	West	Low
371	West	Low	410	West	Low
372	West	Low	412	West	Low
373	West	Low	413	West	Low
374	West	Low	418	West	Low
375	West	Low	420	West	Low
376	West	Low	421	West	Low
377	West	Low	422	West	Low
378	West	Low	425	West	Low
379	West	Low	428	West	Low
380	West	Low	433	West	Low
381	West	Low	434	West	Low
382	West	Low	436	West	Low
383	West	Low	438	West	Low
384	West	Low	440	West	Low
385	West	Low	441	West	Low
386	West	Low	443	West	Low
387	West	Low	445	West	Low
388	West	Low	446	West	Low
389	West	Low	447	West	Low
390	West	Low	448	West	Low
391	West	Low	449	West	Low
392	West	Low	451	West	Low
393	West	Low	452	West	Low
394	West	Low	453	West	Low
395	West	Low	454	West	Low
397	West	Low	455	West	Low
398	West	Low	456	West	Low
399	West	Low	457	West	Low

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